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TRADE LIBERALIZATION AND THE COSTS
AND BENEFITS OF INFORMALITY
AN INTERTEMPORAL GENERAL EQUILIBRIUM
MODEL FOR EGYPT

Abeer Elshennawy and Dirk Willenbockel

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Abstract

This research aims at assessing the costs and benefits of informality for the Egyptian Economy as trade is liberalized. The analytical framework for this assessment is an intertemporal general equilibrium model. The key questions this research will address include: to what extent will informality reduce the transitional unemployment to trade liberalization in the short run –which typically arises due to wage rigidities in the formal sector coupled with asymmetric adjustment of contracting and expanding sectors- and what are the implications for welfare given the lower productivity associated with increased informal employment? In this respect the research will seek to assess the overall balance of the costs and benefits of informality, filling in an important gap in the empirical literature on trade liberalization and informality in general and in the literature on trade policy reform in Egypt in particular. Second: what are the implications of trade liberalization for informal employment and the formal-informal wage gap in the presence of rigid wages in the formal labor market? The purpose of this exercise is to highlight the interaction between trade liberalization and labor market rigidities as drivers of informality.

JEL Classification: *F1, L1*

Keywords: *Informality, transitional unemployment and trade liberalization, Intertemporal general equilibrium model*

ملخص

يهدف هذا البحث إلى تقييم تكاليف وفوائد غير الرسمي للاقتصاد المصري كما هو تحرير التجارة. الإطار التحليلي لهذا التقييم هو نموذج التوازن العام الزمني. الأسئلة الرئيسية التي سيتناولها هذا البحث ما يلي: إلى أي مدى سوف يستطيع الطابع غير الرسمي الحد من البطالة الانتقالية لتحرير التجارة في المدى القصير -وهو ينشأ عادة بسبب الجمود في القطاع الرسمي إلى جانب التكيف مع الأجور غير المتمثلة وتوسيع القطاعات - وما هي الآثار المترتبة على الرعاية الاجتماعية نظرا لانخفاض الإنتاجية المرتبطة بزيادة العمالة غير الرسمية؟ وفي هذا الصدد سوف يسعى البحث إلى تقييم التوازن العام للتكاليف ومنافع الطابع غير الرسمي، وملء ثغرة هامة في الأدب التجريبي على تحرير التجارة و الطابع غير الرسمي بشكل عام وأدبيات إصلاح السياسة التجارية في مصر على وجه الخصوص. ثانيا: ما هي الآثار المترتبة على تحرير التجارة على العمالة غير الرسمية والفجوة في الأجور الرسمية وغير الرسمية في وجود أجور جامدة في سوق العمل الرسمي؟ والغرض من هذا التمرين هو تسليط الضوء على التفاعل بين تحرير التجارة وسوق العمل الجامد كمحفزات للطابع غير الرسمي.

1. Introduction and Statement of Research Problem

One important characteristic of developing economies is the existence of an often large informal sector. The International Labor Office defines informal labor as " all remunerative work – both self-employed and wage employment that is not recognized, regulated or protected by existing legal or regulatory frameworks and non-remunerative work undertaken in an income-producing enterprise" (ILO and WTO 2009,53). Based on this definition then, the informal economy includes (1) informal employment in informal enterprises (including employers, employees, own account operators and unpaid family workers) and (2) informal employment in formal enterprises (including domestic workers, casual or day laborers, temporary or part- time workers, industrial outworkers and unregistered or undeclared workers). The informal sector is generally speaking associated with lower wages and more vulnerability and is where poor, less educated or less trained and mostly female workers work. (Munro 2011). Because job quality is in general poorer in the informal sector, the reallocation of labor from the formal to the informal sector is deemed undesirable. (Goldberg and Pavcnik2003)

Precisely because of its informal nature, estimates of the size of this sector are surrounded by measurement problems due the absence of accurate data. The case of Egypt is no exception in this respect. According to Hendy and Zaki (2012) in 2004, the share of informal firms -defined as firms that are not registered with either an industrial or commercial register – in micro and small enterprises (MSE) stood at 24%. The presence of a large informal sector in Egypt –like in many other developing countries- is commonly explained by overregulation, taxevasion motives and wide spread bureaucratic inefficiencies (AbdelHamid and El Mahdi2003; Abdel Fattah 2012).

Informality may impose costs, yet may also -at certain times- entail benefits. With regards to costs, Galal (2004) reckons that, in general, informal firms are usually less efficient, unable to take advantage of economies of scale and more specialization and division of labor since they are typically small in size. All this undermines the growth potential of an economy. On the other hand, the main benefit of informality stems from its role as shock absorber, providing employment to those that cannot find jobs in the informal sector during difficult times. The mere presence of costs and benefits to informality immediately raises questions about the net benefits to society since only then would it become possible to judge whether it is socially optimal to formalize or not. Within a partial equilibrium framework, the same study asserts that there are substantial gains to firms, workers and society at large from formalization in the case of Egypt *provided* reform is undertaken in an regulatory environment.

Since the contention that informality may impose costs, yet may also – at certain times – entail benefits is most evident in the area of trade reform and it is perhaps best addressed in this context. As will be explained later in detail, by substituting cheaper informal labor for more expensive formal labor, informality provides firms with a mechanism through which they can adjust to competition from imports. Consequently, the incidence of transitional unemployment that can be associated with trade liberalization in the short run can be reduced. On the other hand, informality constraints efficiency and the ability of firms to diversify exports especially up the value chain in the long run. Little empirical evidence is, however, available on the overall balance of costs and benefits of informality in relation to trade reform. (Munro 2011). The immediate implication of this gap in the empirical literature is that the role of informality, particularly in reducing transitional unemployment impacts of trade reform, will remain largely unexploited. As a result, many countries that remain reluctant to liberalize trade in anticipation of

high transitional unemployment would-in many instances- continue to adhere to this inefficient protectionist stance for a longer time than is necessary.

With its large informal sector, Egypt stands out as an example where the role of informality in relation to trade liberalization has been neither fully understood nor has been fully exploited in the sense explained above. Despite efforts to liberalize trade since the early 90's, average tariffs remain high. According to the World Bank, the simple average tariff stood at 17% in 2008. Given high rates of unemployment -standing at 13% in 2013 according to latest releases by the World Bank-concerns about transitional unemployment remain to be one of the main stumbling blocks facing further reductions in trade barriers, depriving the economy of a very important source of economic growth.

While efforts to formalize should not be undermined, the issue of timing of trade liberalization in relation to that of formalization warrants investigation. Exploiting the role of informality in facilitating the transition to free trade can very well imply that trade liberalization should precede formalization. There are, however, tradeoffs involved since informality leads to inefficiency that can offset the benefits of lower wages in the informal sector as a source of competitiveness. Consequently, it may be optimal that formalization precedes trade liberalization. However, formality is not socially optimal in the absence of reform in the regulatory environment as mentioned earlier, and reform in this area in general requires time. Therefore for formalization to precede trade liberalization then the economy is foregoing the gains from a more efficient reallocation of resources and the higher economic growth that are associated with trade liberalization. Clearly, evaluating these trade -offs is essential in order to better exploit the benefits of informality.

In light of the above discussion, this research aims at assessing the costs and benefits of informality for the Egyptian Economy as trade is liberalized. The analytical framework for this assessment is an intertemporal general equilibrium model. Key questions the research will address include: First, to what extent will informality reduce the transitional unemployment to trade liberalization in the short run -which typically arises due to wage rigidities in the formal sector coupled with asymmetric adjustment of contracting and expanding sectors- and what are the implications for welfare given the lower productivity associated with increased informal employment? In this respect the research will seek to assess the overall balance of the costs and benefits of informality, filling in an important gap in the empirical literature on trade liberalization and informality in general and in the literature on trade policy reform in Egypt in particular. Second: What are the implications of trade liberalization for informal employment and the formal-informal wage gap in the presence of rigid wages in the formal labor market? The purpose of this exercise is to highlight the interaction between trade liberalization and labor market rigidities as drivers of informality. It is crucial to note that these rigidities are becoming more and more pertinent following the January 2011 Revolution as raising the minimum wage was one of the most pressing popular demands and was actually first to be implemented by the first post- revolutionary government.

Given that the average productivity of labor in informal firms in Egypt was found to be almost half that in their formal counterparts and the productivity of an informal firm was found to be at most 51% of that of a formal firm(Hendy and Zaki 2012), reform of the regulatory and business environment is envisaged to directly lead to more formalization which in turn is expected to lead to substantial gains in labor productivity and TFP at large. One way to measure the gains from formalization of the Egyptian Economy is to measure the benefits in terms of higher

productivity, TFP, resulting increased competitiveness -if any as trade is liberalized- and growth as well as welfare that becomes possible as firms and labor become formalized. Given the limitations associated with the partial equilibrium nature of existing studies, the current research will explore the general equilibrium effects of increased formalization of labor and firms. This will further help not only assess the costs of informality –measured as forgone gains from formality-, but will also serve to fill another gap in the empirical literature regarding the impact of informality of labor on trade and growth. The issue of sequencing of trade reform and formalization will be also addressed.

The remainder of this paper is organized as follows. Section II provides a review of the theoretical and empirical literature on trade and informality, section III outlines the conceptual framework, section IV describes the model and section V presents simulation results.

2. Literature Review

As mentioned in the introduction, informality may impose costs, yet may also -at certain times- entail benefits and that this is most evident as economies undergo trade reform. (Munro 2011). Before elaborating on this point it is important to note that trade can be one of the main drivers of informality. A recent survey of the theoretical and empirical literature on trade liberalization and informality conducted by Munro (2011) is especially illustrative in this regard. Trade theory can provide some useful insights regarding the relationship between trade liberalization and informality. According to the standard Heckscher-Ohlin Model a country tends to specialize in goods that are intensive in the most abundant factor as trade is liberalized. The Stolper-Samuelson theorem predicts that an increase in the relative price of that good will lead to a relative increase in the reward to the factor of production used intensively in the production of this good. Based on this theory, developing countries which are abundant in low skilled labor should specialize in goods intensive in this factor. Since low skilled labor mainly works in the informal sector, trade theory predicts that informal workers should benefit from trade liberalization as their wages will go up. There is, however, little empirical evidence in support of these predictions.

Within the framework of the Heckscher-Ohlin Model, Marijit, Kar and Beladi (2007) provide further insights regarding the relationship between trade and informality. Their analysis is based on several assumptions. 1) Each of the sectors producing the import competing and export oriented well has both a formal and informal segment. 2) Workers are employed in the informal sectors because they cannot find a job in the formal sector. 3) Finally capital is mobile across sectors, but not across segments (i.e. between the informal and formal segment). Given these assumptions, if trade liberalization leads to a decline in capital prices, and hence a contraction of the formal sector, informal employment and informal wages may rise.

On the other hand, new economic geography provides an explanation for why trade liberalization can be a driver of persistent informality in developing countries. In particular, regional trade agreements that push a member country to specialize in goods in which it has a comparative advantage relative to its trading partners rather than relative to its potential global partners lead to inefficiencies and can be considered as one reason contributing to informality in developing countries. (Munro2011)

However, if some non-traded goods are basically used for consumption purposes, and informality is equated with non-tradables, then the impact of trade liberalization on informality will depend on the reaction of the real exchange rate. If trade liberalization leads to a real

depreciation, then the non-tradable sector contracts and informality falls. The opposite holds true if there is a real appreciation of the exchange rate. (Fugazza and Fiess 2010).

The mechanism through which trade liberalization affects informality -as implicit in the above theoretical discussion - works as follows: if trade liberalization increases competitive pressure on domestic firms, wages must fall to restore competitiveness. However, in reality wages in the formal sectors can be rigid downwards while the wage rate of the informal sector is flexible. Under such circumstances – and to be able to withstand competition from imports- the only option opened for firms is to increase informal employment implying expansion of the informal sector. In this sense, trade liberalization can be a driver of informality in the presence of labor market rigidities. This is however, ultimately an empirical question. Most empirical studies provide mixed results regarding this issue and the evidence is highly country specific, making it intrinsically difficult to generalize (ILO,2009;Fugazza and Fiess 2010). The same remark holds in the case of informal –formal wage gap. (ILO2009).

Two recent empirical studies for Brazil by Bosch et al. (2012) and Paz (2012) show that trade reform have had little impact on informality. On the other hand, in the case of Mexico, Heid et al(2013) show that the expansion of export assembly plants(maquila) since the 1980s has been accompanied by a more than proportionate contraction of non-maquila manufacturing to bring about equilibrium in the balance of payment. As expanding maquila firms could not absorb all released unskilled labor from non-maquila manufacturing, informal employment among unskilled labor increased.

Munro (2011) stresses that the impact of trade liberalization on the informal labor market can vary between the short run and the long run. In the short run, contraction of the formal sector can lead to increase in informal employment and depressed wages of informal workers. However, in the long run and as the formal sector adjusts to increased competition, employment in the informal sector declines. These predictions are consistent with the findings of ILO/WTO (2009). Moreover, the same study finds that trade liberalization is associated with less informality as the economic growth generated leads to expansion of the formal sector in the long run.

The case of Argentina illustrates why the impact of trade liberalization on informality may differ between the short run and long run. Using long time series data spanning the period 1980-2001, Viollaz (2013) shows that trade reform in Argentina was associated with more informality which enabled firms to evade taxes paid on formal labor –like social security- to smooth adjustment to increasing competitive pressure in the short run. In this sense, and as explained earlier, by substituting informal for formal labor, informality becomes a mechanism of adjustment to a trade shock. However, this effect faded over the long run in the tradable sector as firm size within industry increased, as labor moved across sectors and the wages adjusted. As firm size increases, hiring informal workers becomes risky and costly since the probability of detecting tax evasion and paying fines is higher compared to small firms. Moreover, as productive factors become more mobile, part of unemployed labor can be absorbed in the same industry at a lower wage, thus reducing informality. Meanwhile, trade reform was accompanied by an increase in informal employment in non-tradable sectors via the general equilibrium effect in the long run. According to this study, this distinction between the short run and long run explains much of the heterogeneity inherent in the empirical evidence pertaining to the effect of trade liberalization on informality.

Apart from differentiating between the impact of trade liberalization on informality in the long run and short run, it is also crucial to take account the general equilibrium effects of trade reform on informality since it is possible that the reduction of trade barriers might lead to expansion of industries that employ formal labor as opposed to those that employ informal labor in which case trade liberalization might be associated with less informality. It is vital to assess the importance of between industry changes as opposed to within industry changes in explaining informality, though the latter effect seems more important (Goldberg and Pavcnik 2003). Taking account of the impact of trade liberalization on informality via the real exchange channel discussed above is particularly useful also within a general equilibrium framework.

Except for one econometric study by Selwaness and Chahir (2013), there is hardly any empirical research on the relationship between trade liberalization and informality in Egypt. Using Egypt's latest labor market surveys, the study points to increased informality in the manufacturing sector between 1998 and 2006 as the share of informal workers, defined as those that had neither a contract nor social security coverage, increased from 44.4% to 51.6%. Many service sectors also experienced an increase in informal employment over the same period. Although this same period coincided with significant reductions in trade barriers, the authors find that trade liberalization has been associated with a reduction in informality in the manufacturing sector. Along the lines of work by Almen-Castilla (2006), the authors attribute these results to the fact that lower trade costs permit the most productive firms to enter the formal sector and force the least productive informal firms to exit. The most obvious criticism to this study however, is that it does not differentiate between the short run and long run, and no general equilibrium effects of trade liberalization are taken into consideration. In addition, the prevalence of many forms of non-tariff and administrative barriers to trade over the period under study (See, WTO 2005) casts doubt on the role of tariff reductions – on which the research relies - as an ex-post measure of trade liberalization.

Turning back to benefits and costs of informality, one can conclude from the above discussion that one main benefit of informality is that lower wages in the informal sector can permit economies to compete on world markets as trade is liberalized. More importantly, it can reduce transitional unemployment as the formal sector adjusts to increased competition.

Empirical studies of trade liberalization show that economies can and does experience short run transitional unemployment following trade liberalization due to a variety of reasons, the most pertinent of which are rigid labor markets, capital market failure and high transactions costs. (See Michaely et al 1991; Hoekman and Porto 2010; Elshennawy 2011). The basic idea underlying this strand of the literature is that the speed of expansion of export oriented industries can be slower than that of contracting import competing sectors and so released resources – like labor- from the latter sectors cannot be fully absorbed by the former except if wages fall. If wages are rigid downwards, this creates transitional unemployment.

There is considerable empirical evidence that informality has reduced transitional unemployment associated with trade liberalization in the short run in developing countries (Matusz and Tarr 1999). The problem of transitional unemployment, however, acquires new importance in light of the emerging theoretical and empirical literature surveyed in Goldberg and Pavcnik (2007) associating trade liberalization and technological change with rising demand for skilled labor even in developing countries. If competing on world markets and penetrating export markets dictates that firms increase their demand for skilled labor, then competition from imports may exert more downward pressure on wages of unskilled labor, as unskilled workers are typically

more prone to experience falling wages due to their immobility in the short run relative to skilled labor. Under such circumstances and given wage rigidities, transitional unemployment among unskilled labor is likely to be higher than what is predicted under the assumption that the share of skilled versus unskilled labor within industries or sectors remains unaffected by trade liberalization. The benefits of informality in reducing transitional unemployment are thus expected to increase.

On the other hand, the costs of informality are most obvious in the area of trade as informality leads to inefficiencies and constraints exports diversification especially up the value chain. (Munro 2011). It is crucial to recognize that while the emphasis in the theoretical and empirical literature has been on informality as a mechanism that can restore competitiveness in the short run, it can hamper it in the long run due to inefficiencies as it impedes the emergence of dynamic comparative advantage. (ILO 2009). Apart from one recent empirical study by Birinci (2013) showing that there is no robust empirical evidence regarding the interaction between informality and trade openness for 12 advanced economies between 1964 and 2010, there is very little empirical literature on how informality can affect trade and growth as the discussion surrounding this issue remains largely theoretical. (See ILO/WTO2009). More specifically, there is little empirical evidence available on the overall balance of the costs and benefits of informality in relation to trade liberalization. (Munro2011).

Several important questions arise regarding this latter issue. To what extent can informality allow countries to withstand competition from imports and reduce short run transitional unemployment to trade liberalization, particularly if we allow for an increase in the demand for skilled labor over time along the lines discussed above? Addressing this question is important because concerns about transitional unemployment are often one of the reasons underlying the reluctance of policy makers to undertake trade reform. However, if it appears that informality can reduce competitive pressure on firms as they adjust to free trade and reduce transitional unemployment, then it is equally important to assess the extent to which this is true given the trade-off between lower wages and lower productivity associated with informality.

3. Conceptual Framework

Guided by the insights drawn for the theoretical literature surveyed above regarding the role of informality as a mechanism that reduces competitive pressure on firms and facilitates the transition to free trade and the limitations that such role is subject to, and at the same time recognizing the shortcomings inherent in the empirical literature in general and that pertaining to Egypt in particular, the proposed research intends to address the following set of questions for the Egyptian Economy:

First: to what extent can informality reduce the transitional unemployment associated with trade reform under rigid wages in the short run? In particular, are the lower wages associated with informality enough to offset the negative impact on competitiveness of the lower productivity of informal labor? What is the ultimate impact on welfare and growth?

Second: What are the general equilibrium effects of trade reform on informality and the informal wage gap? How is the answer to this question different in the short run versus the long run as wages become more flexible, factors of production become more mobile and the benefits of higher growth generated as a result of trade liberalization become more felt?

Capturing the general equilibrium effect is crucial since as tariffs on industry and agriculture are removed, the resulting expansion (contraction) of these sectors might spur expansion

(contraction) in sectors like services that supply them with inputs. Depending on the share of informal labor in all of these sectors, trade reform might lead to net expansion (contraction) of informal employment.

Third: What is the impact on welfare and growth of a scenario where formalization precedes trade liberalization?

The intertemporal nature of the model utilized in this research is well suited to answer all these questions. The model can capture not only the general equilibrium effects of trade liberalization on informality, but also the implications of the economic growth generated. Both across-sector changes in informality as well as within-sector changes in the share of informal labor that can take place in response to trade liberalization can be studied within the framework of this model. Moreover, with gradual adjustment of the capital stock— due to the presence of adjustment costs to capital— the impact on informality in the short run and long run can be investigated. In addition, issues related to the sequencing of trade liberalization and formalization can be analysed.

4. The Benchmark Model¹

Based on neoclassical growth theory in the tradition of the Ramsey –Cass- Koopman model, consumption and investment are subject to intertemporal behavior. Embedded in this dynamic structure is a within period multi sector open economy static general equilibrium model the full details of which are outlined in Robinson et al (1999). The model draws on the contribution to intertemporal CGE analysis by Go (1991), Mercenier and Sampaio de Souza (1994), Diao and Somwaru (1997), Elshennawy (2011) and Roe et al. (2010), but is extended to account for both population growth and technical progress.

The model distinguishes six sectors of economic activity: agriculture, oil, industry, construction, electricity and services. Output is produced using intermediate inputs and primary factors of production which include labor and capital. To capture the impact of different policy scenarios on the labor market, two skill categories of labor are differentiated production and nonproduction labor. Along the lines of Bourguignon and Savard (2008), the labor market in the model is disaggregated into formal and informal segments. Wages in the formal sector will be assumed to be rigid while that in the informal sector will be assumed to be flexible. In the current research, an additional feature of the labor market will be incorporated in the model. Productivity of formal labor is assumed higher than that of informal labor. The decision of the firm to hire either type of labor is not just based on the wage, but also on productivity.

For simplicity, the role of government is confined to tax collection. Tax revenue is redistributed to the household sector and government expenditure is treated as part of household consumption. The agents in the model are a representative household with infinite planning horizon, a representative firm in each of the production sectors, and the rest of the world, which is linked to the domestic economy via trade, transfer and capital flows. Markets are perfectly competitive. What follows is a description of the dynamic components of the model.

4.1 Consumption behavior

The representative household receives labor and dividend income from firms as well as net transfer income from the rest of the world and the re-transfer of tax revenue. The household chooses the path of consumption that maximizes the intertemporal utility function

¹This section dwells heavily on Elshennawy, Robinson and Willenbockel (2013).

$$U_0 = \sum_{t=0}^{\infty} N_t \ln\left(\frac{C_t}{N_t}\right) \frac{1}{(1+\rho)^t} = N_0 \sum_{t=0}^{\infty} \ln\left(\frac{C_t}{N_t}\right) \left(\frac{1+n}{1+\rho}\right)^t \quad (1)$$

subject to the intertemporal budget constraint

$$\sum_{t=0}^{\infty} R_t P_t C_t \leq \sum_{t=0}^{\infty} R_t [w p f_t FLP_{s,t} + w p i_t ILP_{s,t} + w n f_t FLN_{s,t} + w n i_t ILN_{s,t} + TR_t + TX_t] + W_0 \quad (2)$$

and a no-Ponzi-game transversality condition, where C is a Stone-Geary index of aggregate real consumption, $N = FLP + ILP + FNP + INP$ is household size with FLP, ILP, FNP and INP denoting formal production, Informal production, formal non-production and informal non-production labor respectively, n is the rate of population and labor force growth, ρ is the pure rate of time preference, P is the implicit consumer price index dual to C, w p f, w p i, w n f and w n i are the wage rates for formal production, informal production, formal non-production and informal non-production labor, respectively. TR denotes net transfer income from the rest of the world, TX is tax revenue, W_0 is initial financial net wealth of the household sector, which is equal to the total market value of the firms owned by the representative household minus the initial external debt owed to the rest of the world, and

$$R_t = \prod_{s=0}^t 1/(1+r_s) \quad (3)$$

is the discount factor where r denotes the world interest rate.

The first-order conditions for the maximization of (1) subject to (2) and the transversality condition, which ensures that the given initial debt does not exceed the present value of future current account surpluses, take the form

$$\frac{R_{t+1} C_{t+1} (1+\rho)}{R_t C_t (1+n)} = 1+n_t \quad (4)$$

4.2 Investment Behavior

In each model sector s, firms are aggregated into one representative firm which finances all of its investment through retained earnings and thus the number of equities issued remains constant. Managers seek to maximize the value of the firm. Assuming perfect capital markets, asset market equilibrium requires equal rates of returns (adjusted for risk) on all assets. This implies that the firm's equity must earn an expected rate of return equal to that of a safe asset like foreign bonds as reflected in the condition

$$r = \frac{DIV_s}{V_s} + \frac{\Delta V_s}{V_s} \quad (5)$$

where DIV is dividends, V is the value of the firm $\Delta V_s = V_{s,t} - V_{s,t-1}$ is the expected annual capital gain on firm equity and r is the interest rate on foreign bonds.

Solving the above difference equation (5) forward yields

$$V_t = \sum_{t=0}^{\infty} R_t DIV_t \quad (6)$$

The market value of the firm equals the discounted stream of future dividends. Dividends distributed to the household sector equal operating surplus minus investment expenditure:

$$(7) DIV_{s,t} = PVA_{s,t} f[bFLP_{s,t}, bILP_{s,t}, bFLN_{s,t}, bILN_{s,t}] - w_p f_i FLP_{s,t} - w_{pi} i ILP_{s,t} - w_n f_i FLN_{s,t} - w_{ni} i ILN_{s,t} - PI_{s,t} I_t - ADC_{s,t} \quad (7)$$

where, $f(\cdot)$ is the production function, K is capital, PI is the price per unit of investment I , PVA is the value added price (output price net of indirect production taxes and intermediate input unit costs) and ADC represents adjustment costs associated with the installation of new capital:

$$ADC_{s,t} = PIA_{s,t} \varphi \frac{I_{s,t}^2}{K_{s,t}} \quad (8)$$

Due to the presence of these adjustment costs, the capital stock does not adjust instantaneously to its new optimal long-run level following exogenous shocks that affect the return to capital. Adjustment costs to investment are assumed to be internal to the firm. For any given level of the capital stock these costs are strictly increasing in investment and decreasing in the capital stock for any given level of investment. As a result, firms will find it optimal to increase the capital stock gradually over time in order to reach the optimal long run capital intensity. The adjustment cost function is assumed to be linear-homogeneous in investment and capital. Along with the assumption of constant returns to scale in production, the linear homogeneity of the adjustment cost function entails that Tobin's marginal q equal Tobin's average q (Hayashi 1982). In the general equilibrium model, the real adjustment costs take the form of purchases of installation services, which are a Leontief composite of the construction and industry commodities, and PIA is the unit price of this composite.

The model incorporates labor-augmenting technical progress. It is assumed that the labor efficiency parameters b in (7) grow at the uniform exogenous rate g .

In each specific sector producers maximize the value of the firm subject to the capital accumulation constraint

$$K_{S,(t+1)} = (1 - \delta_S) K_{S,t} + I_{S,t} \quad (9)$$

where δ is the rate of depreciation. Differentiating the Lagrangean for this optimization problem with respect to the control variable I yields

$$q_{S,t} = PI_{S,t} + 2PIA_{S,t} \varphi \frac{I_{S,t}}{K_{S,t}} \quad (10)$$

which determines the shadow price of capital (Tobin's q). Condition (10) states that the firm invests until the cost of acquiring capital –which is equal to the price of a unit of investment plus marginal adjustment costs – is equal to the value of capital.

Differentiating with respect to the state variable K yields the no arbitrage condition

$$PVA_{S,t} f_K + PIA_{S,t} \varphi \left(\frac{I_{S,t}}{K_{S,t}} \right)^2 + (1 - \delta) q_{S,t} - (1 + r) q_{S,t-1} = 0 \quad (11)$$

According to Equation (11) the value of the marginal product of capital $PVA f_K$ plus the marginal reduction in adjustment costs brought by the increase in capital plus the capital gains $q_t - q_{t-1}$ minus depreciation δq must equal the amount foregone rq by choosing to accumulate this extra unit of capital.

For simplicity, there is no differentiation between government and private investment in the model. $I_{S,t}$ is a Cobb-Douglas composite good over commodity groups demanded for investment purposes,

$$I_{S,t} = AK_S \prod_{S'} INVD_{S',S}^{\theta_{S',S}} \quad (12)$$

where $INVD_{S',S}$ is investment demand by sector S for goods of type S' and AK_S is a constant parameter. $PI_{S,t}$ is the investment price index dual to $I_{S,t}$.

4.3 Current account dynamics

The current account dynamics associated with the optimal consumption and investment path is described by

$$D_{t+1} - D_t = r_t D_t + TB_t + TROW_t, \quad (13)$$

where D_t is Debt in period t, TB_t is the trade balance surplus in t and TROW denotes exogenous net transfers from abroad.

4.4 Intratemporal general equilibrium

As mentioned earlier, embedded in this dynamic structure is a standard within period general equilibrium model. Both output and input markets are assumed to be perfectly competitive. Producers in the model use constant returns to scale technologies described by constant elasticity of substitution (CES) value added functions and a Leontief fixed-coefficient technology for intermediate input requirements by commodity group. The CES is a function of skilled labor (non-production labor), unskilled labor (production labor) and capital. In a second stage, each skill category is a CES aggregation of formal and informal labor. For each traded commodity group, exports and domestic goods are combined according to a constant elasticity of transformation (CET). Under the small-country assumption, the demand curve for Egypt's exports is perfectly elastic at fixed world prices. On the demand side, imported and domestic goods are treated as imperfect substitutes in both final and intermediate demand according to the Armington specification. Once more, given the small-country assumption, Egypt faces an infinitely elastic world supply at fixed world prices.

4.5 Properties of the steady-state equilibrium growth path

Technically the dynamic system described by (1) to (13) can be reduced to a saddle point-stable system in the state variable K and co-state variable q. K_0 is predetermined while q_0 is a jump variable. In the absence of shocks to the exogenous parameters of the model, the system can be shown to converge to a steady-state equilibrium, in which q and the sectoral capital stocks per effective labor unit ($K_S/(b(FLP+ILP+FLN+ILN))$) are stationary, while aggregate income, consumption, investment and other macro aggregates grow at the steady-state growth rate $z = g + n + gn$, provided that (using asterisks to denote steady-state levels of variables) $r^* = \rho + g + \rho g$.

The steady-state investment ratio in each sector is

$$\frac{I_{S,t}}{K_{S,t}} = \theta + z \quad (14)$$

The net foreign asset position along the steady-growth path evolves according to

$$(r^* - z)D_t^* = TB_t^* + TROW_t^*. \quad (15)$$

The steady-state growth path market value of the firm in each sector obeys

$$(r^* - z)V_{S,t}^* = DIV_t^*. \quad (16)$$

4.6 Data and calibration

The model is calibrated using the 2006/2007 Social Accounting Matrix (SAM) for Egypt. The SAM is aggregated into six sectors, Agriculture, Mining, Manufacturing, Construction, Electricity and Services. There are two institutions, one Household and the Rest of the World. Assuming that the initial data represents an economy evolving along a steady state growth path, parameters are calibrated so that the model generates a path with a starting point that replicates the observed benchmark data set in the absence of any policy shock like trade liberalization. This dynamic baseline path serves as the benchmark for comparison for the policy scenarios outlined below in section III.

Calibration of all parameters for the intratemporal part of the model follows the standard methods used in comparative-static CGE models. The dynamic calibration proceeds as follows. Based on the UN medium population growth projections for Egypt from 2010 to 2050, the average annual labor force growth rate is set to $n = 0.07$ and the growth rate of labor-augmenting technical progress is set to $g = 0.025$, hence the steady-state growth rate $z = 0.0322$. The rate of capital depreciation is set to $\delta = 0.04$. Total dividend payments are calculated as the difference between the observed value of capital income (gross operating surplus) and the observed value of total investment in the SAM. In order for the model to replicate these observed magnitudes, the pure rate of time preference is set to $\rho = 0.16$, and the adjustment cost parameter is set to $\phi = 1$. These settings jointly determine the initial real capital stock by sector (K_s), q_s and PIs via the steady-state equilibrium conditions, and the parameters AK_s in (12) follow residually.

Data on the initial share of formal versus informal labor across sectors are based on data from the Egypt Labor market panel survey (ELMPS). Wages of informal and formal labor will be also based on the same source. Share of skilled versus unskilled labor as well as the wages of both categories of labor is based on CAPMAS Wages and Hours of Work Bulletin.

5. Simulation Results

Empirical studies of trade liberalization reveal that there are adjustment costs to trade liberalization that are manifested in falling output, rising rates of unemployment and balance of payment problems. (Michaely et al. 1991). These costs mainly arise due to imperfections in labor and capital markets. Imperfections in labor markets arising due to rigid wages in formal labor markets implies that firms cannot lower wages to reduce costs when facing competition from cheaper imports. Consequently, firms have no option but to layoff workers. Credit rationing as well as high interest rates due to oligopolistic behavior on behalf of banks constrain the ability of firms to expand or restructure to be able to compete with imports. (See Bank and Tumlir 1986; Trebilock, Chandler and Howse 1990). Under such circumstances, the capital stock can expand, albeit gradually resulting in asymmetrical adjustment of sectors of economic activity (French-Davis 1986). In particular, export oriented industries can expand at a slower rate than contraction in inefficient import competing sectors and so resources released from inefficient activities are not absorbed in efficient expanding sectors in a timely fashion. Meanwhile, as exports expand at a slower rate than imports, pressure on the balance of payment intensifies. It is important to note that pressure on the balance of payment has been responsible for the reversal of many trade liberalization attempts. These costs are, however, of short run nature (Michaely et al. 1991).

As mentioned earlier, one of the main benefits of informal labor markets is that they can facilitate the transition to free trade by reducing transitional unemployment effects. Because wages in the informal sector are flexible in contrast to the formal sector, firms that have access to cheaper informal labor can lower the cost of production and better withstand competition from imports. Hence, transitional unemployment is reduced, output need not fall as much and pressure on the balance of payment can be small.

Analyzing the role of informal markets in reducing adjustment costs to trade liberalization must begin by assessing the adjustment path in the absence of informal labor markets. The first simulation run thus aims at assessing the transitional adjustment of the economy to trade liberalization under un-segmented labor market, that is before allowing for formal and informal segments of the labor market (SIMU1). Assuming rising demand for skilled labor following trade liberalization, simulation two explores the implications for the adjustment process (SIMU2). To analyze the role of informal labor markets in reducing adjustment costs, simulation two will be re-run under segmented labor markets (SIMU2A). Simulation scenario three assumes that trade liberalization is additionally associated with intrasectoral shifts towards a higher degree of formalization in the tradable sectors (SIMU3). Finally under simulation four, formalization will precede trade liberalization (SIMU4).

Import tariffs in the baseline equilibrium stand at 0.2% for agriculture, 0.1% for oil and 5.5% for industry. The permanent elimination of these tariffs from $t=1$ onwards immediately lowers the domestic market prices of imports relative to domestically produced output for these commodity groups and raises the demand for imports. In SIMU1, aggregate real imports rise by 4.3% in the first period following the trade liberalization shock and by 4.2% along the new steady state growth path after the completion of the transitional adjustment process. The effect is most pronounced for imports of industrial goods (Table 1). In the initial phases of the adjustment process, the trade balance deficit increases significantly and the external debt level rises correspondingly. The intertemporal balance-of-payments constraint requires a reduction in trade balance deficits relative to the baseline path in later periods – indeed in SIMU1 the annual trade balance deficits drop below to the baseline path from $t=7$ onwards to cover the rising debt service payments due to the larger trade deficits in the earlier phases of the adjustment process. Thus, in the longer run the trade liberalization shock is associated with a strong expansion in exports. In SIMU1, the steady-state volume of aggregate exports increases by over 8% relative to the baseline growth path.

At the same time, the reduction in the domestic price of imported capital goods due to the tariff cut lowers investment costs faced by domestic producers in all sectors and thus raises the profitability of investment in productive capital. In SIMU1, the steady-state aggregate real capital stock of the Egyptian economy is 3% higher than in the dynamic baseline equilibrium. The initial phases of this trade-liberalization-induced additional capital accumulation process are primarily financed by foreign savings as reflected by the strong initial increase in the trade balance deficit mentioned above. As the intertemporal utility function of the household sector implies a preference for a smooth consumption growth path over time, only a small fraction of the initial additional investment expenditure is financed through domestic household savings as reflected by the small initial drop in aggregate real consumption relative to the baseline path (Table 1). A closer look at the dynamic time path of aggregate real consumption C shows that C remains below the baseline only for the first three years following liberalization, i.e. from $t=4$ onwards aggregate household welfare is higher than in the baseline equilibrium, and steady-state

real consumption is permanently 0.4 % higher than along the baseline growth path.² Intertemporal welfare as measured by (1) from the perspective of the start of the trade policy reform rises by a very small 0.02%, as the welfare criterion gives a high weight to the initial consumption sacrifices (in period 1 to 3) and applies a high discount to the rising real consumption gains in future decades.

Both nominal and real wages for unskilled (production) and skilled (nonproduction) labor increase along the transition following liberalization. The Egyptian economy thus does not experience transitional unemployment following trade liberalization over the short run in this simulation experiment. As shown in Table 1, trade liberalization is associated with a small increase in the relative wage of skilled to non-skilled labor under SIMU1, since on balance relatively skill-intensive sectors expand more than relatively unskilled-labor-intensive sectors.

As discussed before, there is theoretical and empirical evidence supporting the contention that trade liberalization is associated with increasing demand for skilled labor. Such effects may not only arise as a result of liberalization-induced *intersectoral* structural change in the presence of intersectoral skill intensity differentials, but also as a result of *intrasectoral* change in the composition of firms (e.g. if predominantly less skill-intensive firms within a sector exit in response to increased import competition and if predominantly more skill-intensive firms are able to succeed in export markets). Due to the absence of intrasectoral firm heterogeneity in current-generation CGE models, such *within-sector* effects cannot be captured endogenously within the present analytical framework. Therefore, scenario SIMU2 aims to capture these within-sector effects in a stylized form by combining the trade liberalization shock with a simultaneous permanent exogenous change in the technology parameters that govern the skill intensities of the representative firms in the tradable sectors of the model.

Specifically, under SIMU2 the share parameters of unskilled labor in the value-added production functions are reduced by two percent in the tradable sectors –agriculture, oil, industry and services- implying an increase in the share parameter of skilled labor which in turn will be reflected in rising demand for skilled labor. As shown in Table 1, the directions and general orders of magnitude for aggregate welfare and other macro aggregates are broadly similar to SIMU1, but – not surprisingly – the impact on the skill premium is significantly larger. This suggests that ignoring the effect of trade liberalization on within-sector demand shifts for skilled versus unskilled labor might significantly understate the relative wage effects associated with trade policy reforms.

Assuming that unskilled workers will resist erosion of their relative wage position, holding nominal wages of unskilled labor fixed at their base run value will result in unemployment. When SIMU2 was run under rigid nominal wages for unskilled labor, unemployment amounted to 4.4% in period one. This is a novel result in relation to studies addressing adjustment to trade liberalization which ignore the fact that free trade in practice is associated with increasing within-sector demand for skilled labor and is so likely to be associated with short term transitional unemployment over and above what takes place due to intersectoral structural change as discussed above.

² At first sight, this figure might look surprisingly low, given the large steady-state increase in the aggregate real capital stock (which is associated with a steady-state increase in real GDP on the order of 2.2 percent). However, it must be borne in mind that a large fraction of the additional capital stock is used to produce the additional exports required to finance the increase aggregate imports – or stated differently, to service the increase in the external debt associated with the optimal consumption smoothing effect outlined above.

Before presenting the results with formal-informal labor segmentation, it is useful to present the main features of the labor market in Egypt according to Egypt's Labor Market Survey for the year 2006, the year which coincides with the SAM used in this paper. Table 2 below shows that informal labor is mainly concentrated in agriculture, accounting for roughly 95% of total employment in this sector. The second sector where informality is also rampant is in the construction sector where informal labor accounts for 83% of total employment, followed by the trade services sector where informality accounts for 74% of total employment, and manufacturing where informality accounts for 51% of total employment.

The table also shows that informality is mainly prevalent among unskilled workers. The bulk of informal labor is unskilled in agriculture, followed by the transportation and mining sectors. In these three sectors, unskilled labor constitutes 99%, 92%, and 85% respectively of total informal labor. However, in manufacturing, unskilled labor constitutes 21% of informal labor. Meanwhile, the wage differential between informal and formal labor for the unskilled and skilled labor is significant as is evident from table 3.

Turning back to simulation results, simulation two is now run while allowing for segmented labor markets (SIMU2A). Real wages for both formal unskilled and skilled labor increase along the transition as a result of trade liberalization coupled with increasing demand for skilled labor. Therefore, under segmented labor markets, there is no transitional unemployment.

While the general orders of magnitude of the results for SIMU2A reported in Table 4 appear quite similar to the results for SIMU2 in Table 1 at first sight, a closer inspection reveals noteworthy differences: Although the aggregate intertemporal welfare gain remains tiny under SIMU2A, it is nearly 80% higher than in SIMU2. The reason is that in contrast to SIMU2 no initial real consumption sacrifice is required in the first periods after the tariff cuts to finance the trade-reform-induced increase in aggregate real investment. Instead, aggregate real consumption rises immediately and remains above the baseline path during the whole transition process. Thus, in terms of the time profile of aggregate real consumption, the adjustment to the trade policy shock is smoother in the presence of informal labor markets. This is possible because steady-state output is higher across *all* sectors (Table 5) under SIMU2A, and thus the tradable sectors can generate additional long-run export revenue without a reduction in long-run domestic consumption. Correspondingly, the economy can afford to run higher initial trade deficits in the early phase of the transition process than under SIMU2. In other words, the additional long-run real production and export capacity allows a higher initial foreign borrowing rate without violation of the intertemporal budget constraint, which in turn allows raising both aggregate investment and aggregate consumption at the start of the adjustment process. The deep theoretical explanation for the marginal additional equilibrium real output increase in SIMU2 lies in the fact that the presence of substitution possibilities between formal and informal labor opens an additional channel through which producers in the model can respond optimally to the policy shock. This important result confirms the earlier mentioned conjecture that the presence of informal labor markets can add an additional element of flexibility in the adjustment of the economy to trade policy reforms or other exogenous shocks.

Scenario SIMU3 combines the tariff cuts and shifts towards higher skill intensity in tradable sectors (as in SIMU2 and SIMU2A) with an exogenous within-sector shift towards a higher degree of formalization induced by trade liberalization in the tradable sectors. Formalization is modeled as a 3% increase in the share parameters of formal unskilled and skilled labor and a corresponding reduction of the share parameters for informal labor in the sectoral production

functions for tradables. As shown in Table 4, the result is a significant increase in the formal-informal wage gaps under the assumption of an inelastic relative labor supply response.³ The aggregate intertemporal welfare gain is noticeably higher than under SIMU2A, but the distribution of these gains favors formal workers disproportionately in the absence of compensatory measures.

The final simulation scenario (SIMU4) explores issues related to the sequencing of trade liberalization and formalization. The main question here is whether it is better to liberalize trade and take advantage of the presence of informal labor markets now or formalize first and liberalize trade later. Under this simulation, formalization is assumed to take place gradually over three years whereby the share parameters of formal unskilled labor and skilled labor each increase by 1% per year so that they are 3% above the base run by year three. Trade is liberalized in year 4 and is again associated with an exogenous within-sector shift towards skilled labor.

Of crucial importance for the intertemporal dynamics of this scenario is the assumption that the forward-looking agents in the model are not caught by surprise by the permanent tariff cut in $t=4$. Rather, the government credibly commits itself at the start of $t=1$ to lift tariffs in four years time and publicly announces this decision. Since marginal capital stock adjustments rise with the speed of investment, there is an incentive for firms to start the real investment required to raise the capital stock to the new higher optimal long-run level well ahead of the trade policy implementation date. In other words, the real capital stock adjustment costs are lower if the investment process is spread out over time in anticipation of the future policy change. Therefore real investment starts to rise gradually as soon as the future trade policy reform is announced – a pure policy anticipation effect⁴ (Table 6).

However, as the delayed cut in tariffs means that consumers still face the higher tariff-distorted consumer prices in period $t=1$ to $t=3$, as the consumer price only drops significantly after the trade reform implementation date in $t=4$, real consumption must drop during the initial implementation lag phase to generate sufficient domestic savings for the initial capital accumulation phase. In consequence, the aggregate intertemporal welfare impact is noticeably lower than in the corresponding scenario without sequencing (SIMU3). This result indicates that a sequential policy reform approach in which efforts to raise the degree of formalization precede trade liberalization is not advisable, as the gains foregone by delaying trade policy reform are likely to dominate the outcome.

6. Conclusions and Policy Implications

This study throws new light on the adjustment process to trade policy reforms in the presence of informal labor markets.

A review of the literature shows considerable theoretical and empirical evidence supporting the contention that trade liberalization is associated with increasing demand for skilled labor even in developing countries. Such effects may not only arise as a result of liberalization-induced intersectoral structural change in the presence of intersectoral skill intensity differentials, but also as a result of intrasectoral change in the composition of firms. Our simulation results for Egypt

³ Obviously, the increase in the wage gap would be lower if facilitating policy measures are in place that raise the ability of workers to move from the informal to the formal segments of the economy.

⁴ For an analysis of trade policy anticipation effects in an intertemporal general equilibrium model without international capital mobility see Willenbockel (1998).

indicate that the impacts of such intrasectoral effects on skill premium are likely to be far stronger than the corresponding relative wage effects of intersectoral structural change in response to trade liberalization. This suggests that ignoring the effect of trade liberalization on within-sector demand shifts for skilled versus unskilled labor might significantly understate the relative wage effects associated with trade policy reforms. In particular, rising demand for skilled labor that takes place as exporters try to penetrate export markets following the liberalization of trade translates into falling demand for unskilled labor, an issue that has been largely overlooked in the literature pertaining to adjustment costs to trade liberalization.

The current research further provided quasi-empirical evidence in support of the contention that informality can reduce adjustment costs to trade liberalization. The presence of informal labor markets can add an additional element of flexibility in the adjustment of the economy to trade policy reforms or other exogenous shocks.

Furthermore, important implications for the sequencing of trade liberalization and formalization of labor markets emerge from this study. To reduce adjustment costs to trade liberalization, policy makers should take advantage of the presence of informal labor markets rather than opt for formalization first followed by trade liberalization. A sequential policy reform approach in which efforts to raise the degree of formalization precedes trade liberalization is not advisable, as the gains foregone by delaying trade policy reform are likely to dominate the outcome.

From a methodological perspective, this study demonstrates that the adoption of an intertemporal approach is crucial for a meaningful analysis of the adjustment processes in response to trade policy shocks. In particular, the results show clearly that, contrary to the widely held view, a temporary increase in the trade balance deficit following trade liberalization is by no means a problem, but rather part of the rational optimal response to the policy change, as the higher deficits serve to lower the economy-wide adjustment costs by smoothing out the impacts on the intertemporal time profile of aggregate consumption.

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Table 1: Simulation Results without Formal-Informal Segmentation (Percentage Deviations from Dynamic Baseline Path)

	SIMU1		SIMU2	
	t =1	Steady State	t =1	Steady State
Real Consumption	-0.03	0.39	-0.04	0.39
Real Investment	2.57	3.00	2.63	3.63
Consumer Price Index	-1.50	-2.00	-1.50	-2.00
Import Volume	4.25	4.20	4.26	4.20
Export Volume	3.00	8.49	2.97	8.58
Real Capital Stock	0.00	3.00	0.00	3.06
Intertemporal Welfare		0.018		0.018
X _{IND}	-0.25	1.00	-0.32	0.95
M _{IND}	6.02	6.16	6.05	6.18
WLNP/WLP	0.10	0.40	2.80	3.00

Table 2: Informal Employment in 2006

	Share of Informal Labor in Total Employment (%)	Share of Unskilled Labor in Total Informal Employment (%)
Agriculture	94.53	99.46
Mining	22.94	85.05
Manufacturing	51.30	21.96
Electricity	1.46	0.00
Construction	82.67	4.48
Trade	73.86	56.61
Transportation	39.89	92.41
Finance	1.87	51.53
Services	17.12	69.83

Source: Author calculation based on data from Egypt Labor Market Panel Survey for 2006

Table 3: Informal/Formal Wage Differential 2006

	Skilled	UnSkilled
Agriculture	0.43	0.92
Mining	0.50	0.35
Manufacturing	0.52	0.73
Electricity	0.50	0.5
Construction	0.58	0.83
Trade	0.75	0.7
Transportation	0.26	0.82
Finance	0.11	0.12
Services	0.51	0.98

Source: Author calculation based on data from Egypt Labor Market Panel Survey for 2006

Table 4: Simulation Results with Formal-Informal Segmentation (*Percentage Deviations from Dynamic Baseline Path*)

	SIMU2A		SIMU3	
	t =1	Steady State	t =1	Steady State
Real Consumption	0.03	0.50	0.13	0.72
Real Investment	2.78	3.25	3.33	3.80
Consumer Price Index	-1.40	-2.00	-1.40	-2.10
Import Volume	4.36	4.31	4.61	4.56
Export Volume	3.01	8.95	2.99	9.89
Real Capital Stock	0.00	3.26	0.00	3.80
Intertemporal Welfare		0.032		0.056
X _{IND}	-0.19	1.25	-0.06	1.78
M _{IND}	6.13	6.28	6.39	6.53
WLNP/WLP	2.20	2.50	2.00	2.30
WPF/WPI	0.00	0.20	6.60	6.80
WNF/WNI	-0.70	0.00	6.30	7.10

Table 5: Impacts on Steady State Real Output by Sector and Scenario (*Percentage Deviations from Dynamic Baseline Path*)

	Agriculture	Oil	Industry	Construction	Electricity	Services
SIMU2	1.01	6.72	0.95	2.27	1.04	1.69
SIMU2A	1.23	6.91	1.25	2.41	1.18	1.88
SIMU3	1.63	7.43	1.78	2.98	1.45	2.41
SIMU4	1.77	7.07	1.80	2.97	1.63	2.42

Table 6: Simulation Results with Formal-Informal Segmentation – SIMU4 (*Percentage Deviations from Dynamic Baseline Path*)

	SIMU4				
	t=1	t=2	t=3	t=4	Steady State
Real Consumption	-0.67	-0.68	-0.69	+0.52	+1.14
Real Investment	+0.15	+0.41	+0.69	+4.04	+3.76
Consumer Price Index	-0.20	-0.20	-0.20	-1.30	-2.00
Import Volume	-0.67	-0.61	-0.55	+5.15	+4.98
Export Volume	+0.99	+1.06	+1.14	+2.47	+9.22
Real Capital Stock	0.00	+0.01	+0.04	+0.09	+3.76
Intertemporal Welfare			+0.046		
X _{IND}	+0.05	+0.01	-0.03	-0.33	+1.80
M _{IND}	-0.66	-0.59	-0.50	+7.00	+6.95
WLNP/WLP	-0.10	-0.10	-0.20	+2.00	+2.30
WPF/WPI	+2.20	+4.30	+6.60	+6.50	+6.70
WNF/WNI	+2.20	+4.60	+7.00	+6.20	+7.10

Appendix

Within period equations (the time subscript is omitted to simplify notation)

Price block

Domestic price of imports

$$PM_s = [1 + \tau m_s] ER.PWIM_s \quad 1$$

Domestic price of exports

$$PE_s = [1 + \sigma e_s] ER.PWE_s \quad 2$$

Domestic supply price

$$PC_s = PD_s \frac{D_s}{C_s} + PM_s \frac{M_s}{C_s} \quad 3$$

Domestic output price

$$PX_s = PD_s \frac{D_s}{X_s} + PE_s \frac{E_s}{X_s} \quad 4$$

Value added price

$$PVA_s = [1 - \tau i_s] PX_s - \sum_{SP} IO_{(SP,S)} PC_{SP} \quad 5$$

Price of investment (unit cost function for producing investment good)

$$PI_s = \frac{\prod_{s'} PC_{s',s}^{\theta_{s',s}}}{AK_s \cdot \prod_{s'} \theta_{s',s}^{\theta_{s',s}}} \quad 6$$

Output supply and demand block

$$X_s = AX_s \left[\sum_j^M \alpha_{s,j} (bF_s)^{-\rho_{XS}} \right]^{-1/\rho_{XS}} \quad 7$$

F stands for factor of production which include production labor, non-production labor and finally capital while M is number of factors of production, $j=1 \dots \dots M$. In turn each skill category is a CES aggregation of formal and informal labor.

Assuming that firms maximize profits given the above CES production function, we arrive at the demand function for each factor of production.

Intermediate demand

$$INTD_s = \sum_{s'} IO_{(s,s')} X_s' \quad 8$$

Intermediate inputs are combined according to an Leontif technology with fixed coefficients IO to produce output

Armington

$$C_s = AC_s [\delta_s M_s^{-\rho_{Cs}} + (1 - \delta_s) D_s^{-\rho_{Cs}}]^{-1/\rho_{Cs}} \quad 9$$

Minimizing the costs of imports and output consumed domestically subject to 9 leads to Import demand

$$M_S = D_S \left[\frac{PD_S \delta_S}{PM_S (1 - \delta_S)} \right]^{1/(1+\rho C_S)} \quad 10$$

CET

$$X_S = AT_S [\gamma_S E_S^{\rho T_S} + (1 - \gamma_S) D_S^{\rho T_S}]^{1/\rho T_S} \quad 11$$

Maximizing the value of exports and output consumed domestically subject to 11 leads to Export supply

$$E_S = D_S \left[\frac{PE_S (1 - \gamma_S)}{PD_S \gamma_S} \right]^{1/(\rho T_S - 1)} \quad 12$$

Factor and institution block

Household flow income

$$YH_t = w p f_t FLP_{s,t} + w p i_t ILP_{s,t} + w n f_t FLN_{s,t} + w n i_t ILN_{s,t} + \sum_S DIV_{(s,t)} + THG_t - ER.r_t D_{(t-1)} \quad 13$$

Household demand

$$PC_S CD_S = a_S (YH - SAV) \quad 14$$

Sectoral investment demand (by sector of origin)

$$PC'_S INVD_{(s',s)} = \theta_{(s',s)} PI_S . I_S \quad 15$$

Government transfers

$$THG = \tau i_S PX_S X_S + \sum_S \tau m_S . ER . PWIM_S - \sum_S \sigma e_S . ER . PWE_S . E_S \quad 16$$

Equilibrium conditions

Factor market equilibrium

Demand for each factor of production=Supply of that factor

$$\sum_S FLN_S = SFLN \quad 17$$

$$\sum_S ILN_S = SILN \quad 18$$

$$FLP_S = SFLP_S \quad 19$$

$$ILP_S = SILP_S \quad 20$$

$$KD_s = K_s$$

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Commodity market Equilibrium

$$C_s = CD_s + INVD_s + INTD_s \quad 22$$

Current Account

$$\sum_s PWIM_s M_s - \sum_s PWE_s E_s = TB \quad 23$$

Glossary

Variables:

TC_t = Aggregate consumption

CD_(s,t) = private consumption of good s

R_t = discount factor from time t to time zero

Ptc_t = the price of total consumption

wpf_t = wage rate of formal production labor

wpi_t = wage rate of informal production labor

wnf_t = wage rate of formal non- production labor

wni_t = wage rate of informal non- production labor

FLP_{s,t} = demand for formal production labor

ILP_{s,t} = demand for informal production labor

FLN_{s,t} = demand for formal nonproduction labor

ILN_{s,t} = demand for informal production labor

KD_{s,t} = demand for capital

SFLP_{s,t} = labor supply of formal production labor

SILP_{s,t} = labor supply of informal production labor

SFLN_t = labor supply of formal non-production labor

SILP_t = labor supply of informal non-production labor

K_(s,t) = capital stock

THG_t = transfer of government revenue to household

r_t = instantaneous interest rate

ω = value of the household initial financial wealth

PVA_(s,t) = value added price

I_(s,t) = Investment

$INVD_{(S',S)}$ = investment demand by sector of origin
 $PI_{(S,t)}$ = price of new capital good
 D_t = foreign Debt
 TB_t = trade balance
 $PD_{S,t}$ = domestic good price (sold domestically)
 $PM_{S,t}$ = domestic price of imports
 $PE_{S,t}$ = domestic price of exports
 $PC_{S,t}$ = domestic supply price
 $PX_{S,t}$ = domestic output price
 ER = exchange rate
 PWE_S = supply price of exports
 $PVA_{S,t}$ = value added price
 $D_{S,t}$ = quantity of domestic output sold domestically
 $M_{S,t}$ = quantity of imports
 $E_{S,t}$ = quantity of exports
 $C_{S,t}$ = quantity of good supplied domestically
 $X_{S,t}$ = quantity of domestic output
 $INTD_{S,t}$ = intermediate demand of good S
 TB = Foreign savings
 $LSUP_P$ = supply of production labor
 $LSUP_{NP}$ = supply of non production labor
 YH_t = household income
 D_t = foreign debt
 SAV_t = household saving
 $CD_{S,t}$ = HH demand for good S
 $INVD_{S',S}$ = sector S investment demand for good S' (investment demand by sector of origin)
 $I_{S,t}$ = new investment

Parameters

δ_S = depreciation rate
 AK_S = shift parameter in the investment function
 τ_{ms} = import tariff rate

σ_{es} = export subsidy rate
 τ_{is} = input output coefficient
 $PIWM_s$ = world price of imports
 $PIWE_s$ = world price of exports
 $\theta_{s',s}$ = share of good s' in sector s investment
 AK_s = shift parameter in the investment production function
 AX_s = production function shift parameter
 $\alpha_{s,j}$ = share of factor j in CES production function
 ρ_{X_s} = CES exponent
 AC_s = shift parameter in Armington elasticity
 δ_s = share parameter in Armington
 ρ_{C_s} = Armington exponent
 AT_s = shift parameter in CET
 γ_s = share parameter in CET
 ρ_{T_s} = Armington exponent
 σ_{C_s} = elasticity of substitution between domestic goods and imports
 σ_{T_s} = elasticity of substitution between domestic use and exports
 τ_d = direct tax rate
 a_s = spending share for HH on good S
 $\theta_{s',s}$ = share of good s' in sector s investment
 r = interest rate