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## Abstract

This paper examines the effects of international capital flows in a small open economy utilizing a dynamic general equilibrium framework based on a three-sector Ramsey growth model. In order to analyze the impact of international capital mobility on production, consumption and allocation of resources across three sectors, two different economic environments are modeled. The first model represents an open economy with capital mobility (a more comprehensive environment), and the second model introduces a closed economy with without capital mobility. Numerical applications of the models use data from the Turkish economy for the year 2002. The numerical results demonstrate that the presence of capital mobility, despite being limited by a borrowing constraint, reverses the impact of economic growth on production and resource allocation. The results also show that while production in the closed economy model simply adjusts to domestic demand, That of the open economy model is not constrained by it. Results further point that although there is positive growth in income and output in both environments, income growth in the capital mobility environment falls short of that of the environment without capital mobility. This result can be attributed to the relatively slower accumulation of capital in the former, which may be compensated by a positive rate of technological progress to accompany international capital flows.



## ملخص

تبحث هذه الورقة آثار تدفقات رأس المال الدولية في اقتصاد صغير بإستخدام إطار ديناميكي عام متوازن بناء على نموذج نمو رامسي ثلاثي القطاعات. و من أجل تحليل أثر انتقال رؤوس الأموال الدولية على الاستهلاك والإنتاج وتخصيص الموارد عبر ثلاثة قطاعات ، تم نمذجة بيئتين اقتصاديتين مختلفتين . النموذج الأول يمثل اقتصاد مفتوح مع حركة رأس المال (بيئة أكثر شمولا) ، والنموذج الثاني يشير إلى اقتصاد مغلق دون حركة رأس مال . و تم استخدام التطبيقات العددية لنماذج بيانات من الاقتصاد التركي لعام 2002. بحيث اثبت النتائج الرقمية أن وجود حركة رؤوس الأموال ، و على الرغم من كونها محدودة بقيد الاقتراض ، الا انه تعكس تأثير النمو الاقتصادي على الإنتاج وتخصيص الموارد . وتظهر النتائج أيضا أنه رغم أن الإنتاج في نموذج الاقتصاد المغلق يستجيب للطلب المحلي ، الا ان نموذج الاقتصاد مفتوح ليس مقيدا به. و تشير النتائج إلى أنه هناك نموا إيجابيا في الدخل والناتج لكلتا البيئتين، كما ان نمو الدخل في بيئة انتقال رؤوس الأموال لا يتحقق في بيئة عدم تنقل رؤوس الأموال. ويمكن أن تعزى هذه النتيجة إلى التراكم البطيء نسبيا لرأس المال في السابقة، الأمر الذي قد يعوض بنسبة إيجابية من التقدم التكنولوجي لمواكبة تدفقات رأس المال الدولية.

## 1. Introduction

International capital flows have become an indispensable part of global economies of the 21st century. Economic growth has been constrained by the boundaries of domestic markets since countries had to rely on their own saving and investment capabilities. However, the presence of international capital flows proposes a remedy to this problem by providing the countries with the opportunity to make use of the global resources and share the risks associated with investment. Thus, it would seem that the limits of domestic markets for economic growth cease to be a constraint for the global economies of the 21st century. This line of thinking encourages the countries with closed capital accounts to engage in financial integration by liberating their capital accounts. Nonetheless, many emerging economies experienced financial crises after capital account liberalization which casts a doubt on the prospects offered by the presence of a global financial market. Thus, the arguments raised in favor of financial integration started to lose ground leading to a re-evaluation of the benefits and costs of international capital flows. In that sense, much of the questioning is directed towards the validity of capital account liberalization and whether it exerts a positive influence on economic growth for the country in question, or not. (Akgül, 2009)

Within the framework of an open economy Ramsey model, this study will examine the impact of international capital mobility on the economy by focusing on the domestic allocation of resources across multiple sectors. The focus on multiple sectors provides a more informative and detailed analysis on the growth effects of financial openness. As is discussed in Aykut and Sayek (2007), in models of real economy, not only the presence of free international capital flows, but also the sectoral composition of them are decisive in economic growth. In fact, they suggest that if international capital flows are channeled towards the manufacturing sector, economic growth will be improved. On the other hand, if they are channeled towards primary goods or services sectors, then economic growth might be affected negatively. Therefore, if financial liberalization is considered in the context of multiple sectors, the analysis will include the sector specific factors of international capital flows and present more grounded conclusions. Based on this perspective, in this study production will take place in three sectors. One of the sectors is the tradable-goods sector which produces all the internationally tradable goods in the economy at world prices. The domestic production in this sector is for international markets. The other sectors are the home services and the non-tradable-goods sectors which produce for the domestic market. The prices in these sectors are endogenously determined within each respective domestic market. In all these sectors output is produced using three inputs: raw labor, physical capital and human capital. Production sectors are different from each other on the basis of their relative factor intensities and the nature of their output. Moreover, the accumulation of physical and human capital takes place in different sectors as the economy allows for international capital mobility.

The procedure to be followed is to compare and contrast the movements of factors of production across sectors under two different institutional arrangements, in the balanced growth path (or at the steady state equilibrium). The first environment represents an economy with financial openness which will serve as a benchmark framework. The economy in this environment will be open to international trade in goods, and partially open to international capital flows. By partial capital mobility we imply that the country can borrow from the rest of the world by using only part of its accumulated capital stock as collateral. In the second environment, the economy will be closed to international borrowing and lending, i.e., it will be a more constrained environment. In short, the environments are differentiated from each other by the presence of international capital flows. The distinction between these models is also demonstrated in the determination of the rate of return on internationally mobile capital. In the open economy model, since international capital flows are allowed and the country can

borrow using part of the accumulated capital stock as collateral, the rate of return on the mobile capital is pegged at the constant world interest rate.[1] In the no capital mobility model, foreign borrowing is zero and the rate of return on capital is endogenously determined in the domestic market.

In the open economy Ramsey growth model with international capital mobility, the constancy of the interest rate leads to problematic outcomes, such as an infinite rate of convergence towards the long-run equilibrium. In this study, the problems of the open economy Ramsey framework will be overcome by allowing for non-tradable investment goods. Consistent with the literature and specifically following Barro et al. (1992, 1995) in this study we assume imperfect capital mobility by imposing a borrowing constraint on the domestic economy. In that fashion, two types of capital exist and accumulate in this economy, physical and human capital types, and human capital is assumed to have a non-tradable nature in international markets. Based on this assumption, investment in physical capital may be made possible through foreign borrowing under a collateral constraint, while investment in human capital stock can only be through domestic means.

After establishing the framework, both models are calibrated to the Turkish economy for the year 2002. This study examines the changes in production, consumption and reallocation of resources across sectors as the economy moves from an initial equilibrium towards its long-run equilibrium. Accordingly, the outcomes from the two models will be compared so that a conclusion about the impact of international capital flows on the real economy will be made. In contrast to Barro et al. (1992, 1995) and Barro and Sala-i-Martin (2004), this study incorporates three distinct sectors. It is informative to scrutinize the changes taking place in production and resource allocation recognized in various sectors. In the traditional Ramsey model with a single sector, capital accumulation is afforded by lower consumption and higher saving of the domestic agents. However in this analysis, it will be shown that the required investment is not necessarily financed by decreased consumption and increased saving in a multi-sector environment. Particularly in the non-capital mobility economy model, economic growth is financed by leaving consumption behavior rather smooth and re-allocating the investment opportunities of sectors within themselves, leading to movements of factors of production across sectors. However in the partial capital mobility environment, investment is financed not only by accessing other sector's resources, but also by utilizing the international sources through financial integration. As capital deepening takes place in the partial capital mobility economy, sectoral reallocation of resources follows a different pattern as compared to the non-mobility economy, thus a different output pattern materializes in the long-run. In that sense, we believe that examining the changes taking place in a three-sector environment will contribute to the understanding of open economies.

This paper is organized as follows: In Section 2, a brief discussion on the link between capital account liberalization and economic growth will be provided. Section 3 describes the basic properties of the overall model and gives the details of the partial capital mobility and non-capital mobility models, and characterizes equilibria in both environments. Section 4 summarizes the data used in the numerical exercise and introduces the numerical results from the models. Section 5 concludes the study.

## 2. Capital Account Liberalization and Economic Growth

There are many studies in the literature concerned with the growth impact of international capital flows and each of them reaches different conclusions. Some of the studies argue in favor of capital account liberalization based on theoretical explanations and empirical findings. There are basically two types of benefits of financial integration according to

[1] We assume that the rest of the world is in steady state.

Gourinchas and Jeanne (2002). The first one is the international allocative efficiency. As noted by Fischer (1998), financial integration utilizes international capital in its most productive use so that it provides the most efficient allocation of global savings. This efficiency in allocation leads to higher gains in terms of economic growth compared to the case when financial liberalization is restricted. As discussed by Obstfeld (1998) and Edison et al. (2002), the efficiency in allocation of world savings also enables the capital poor countries to obtain the necessary capital through international flows and provides an inter-temporal consumption smoothing in times of output shocks. Thus, the industrializing countries, which are short of capital and undergoing recessions, would be able to access international capital and thereby finance their investments through foreign borrowing.

The second type of benefits is the domestic allocative efficiency. According to Saggi (2002), financial integration, specifically through FDI, could lead not only to an import of more efficient foreign technologies in developing economies, but also it would generate technological spillovers to domestic firms. Saggi (ibid.) states that potential channels of spillovers work through demonstration effects (imitation or reverse engineering), labor turnover (transfer of technological know how from foreign firms to domestic firms through labor switching employers or starting own firms), or vertical linkages (transfer of technology to domestic suppliers from foreign firms). Gourinchas and Jeanne (2002) also argue that financial integration could lead to increases in productivity in the domestic economies by allowing inflows of FDI in sectors where foreign firms operate with a productivity advantage, which eventually spills over to the domestic firms that compete with these foreign entrants via increases in productivity of domestic labor. Mello (1999) presents a two-fold effect of FDI on economic growth: first, through capital accumulation in the host economy, FDI is expected to enhance growth by introduction of new inputs and new technologies in the production of the host economy. Secondly, through knowledge transfers, FDI is expected to contribute to the existing stock of knowledge in the recipient economy mainly through labor training and skill acquisition, and also through more efficient management practices. Borensztein et al. (1998) on the other hand show that the argument that FDI leads to higher productivity in the host economy holds true only for a minimum treshold for human capital: the FDI enhances productivity and economic growth only when a sufficient absorbtive capacity for advanced technologies in the host economy exists.

In contrast to the growth-enhancing effects of financial integration pictured above, many authors argue against it and pose empirical evidence showing the adverse effects of international capital flows. For instance, Krugman (1993) argues that neither economic theory nor the past evidence confirms the acceleratory role of financial integration on economic growth since the access to foreign capital is not an engine for growth by itself, even though it leads to capital accumulation in the country. Similarly, according to Rodrik (1998) and Edison et al. (2002), financial integration is not associated with economic growth even when per capita income levels, institutional qualities and school enrollment rates are controlled for. Even though Arteta et al. (2001) come up with indications of a vague positive relationship between capital account liberalization and growth, the findings show that it is conditional on time, measurement and estimation. Finally, according to Mundell (cited in Obstfeld, 1998) international capital flows might affect wages as commodity imports would do. Since international capital can be invested anywhere in the world, it would be placed in its most productive use with the least cost possible. Thus, commodities will be produced in the countries with low labor costs. This leads to two effects. Since lower costs lead to lower prices, importing the commodities in question would be cheaper than production which causes unemployment in high-cost countries. Moreover, since capital markets are open, factor

prices are equalized all over the world which causes a decline in the wage rates. Either effect is a distortion to the well-being of a country.[2]

The theoretical discussions and empirical findings on the benefits and negative side effects of capital account liberalization provide a limited analysis of international capital flows. In order to observe their practical implications on economic growth and convergence, many surveys utilize neoclassical growth models. By calibrating neoclassical models of real economy, the overlooked details in theoretical explanations and empirical surveys could be filled in. The benchmark framework in convergence and growth literature is to use the Ramsey (1928) model of optimal consumption and saving. Within the bounds of a closed economy, the model has been used to show that there is conditional convergence among economies. Even though Ramsey model performs well in closed economy frameworks, it encounters several difficulties when international capital flows are introduced. As is discussed in Barro et al. (1992, 1995) and Barro and Sala-i-Martin (2004), there are three possible problems related to the open-economy version of the Ramsey Model. The first problem is the infinite rate of convergence observed in the economy when international capital flows are allowed eliminating any transitional behavior of endogenous variables. The second problem associated with the model is that when there is a difference in the time preference rates, the most patient country will have a high consumption level, while the consumption per capita in an impatient country will approach zero. The third problem faced by the model is the wealth effect which claims that impatient countries end up with negative wealth. The aforementioned problems related to the open economy version of the Ramsey Model have been scrutinized in the growth literature. There are three main solutions offered by these studies. One of the methods is introducing adjustment costs in investment in order to slow down the adjustment of capital stock to its steady state level. Another way to deal with the problems of the open economy Ramsey Model is endogenizing the time preference parameter such that it is different for every country. This would reduce the gap between the interest rate and the time preference parameter. Still another method is allowing for non-tradable investment goods in the economy which leads to imperfect capital mobility in world financial markets.

According to Gourinchas and Jeanne (2002), the economies that experience infinite convergence rates after opening their capital accounts, are, in fact, close to their conditional steady states. As is discussed in Mankiw et al. (1992), this closeness might result from a low capital share in production which increases the speed of diminishing returns to capital. In order to deal with this problem, they introduce human capital into the model so that the share of capital in production is increased. As a result, diminising returns to capital slows down. Inspired by the idea, Barro et al. (1992, 1995) and Barro and Sala-i-Martin (2004) introduce two types of capital stocks into the model, namely physical and human capital. They assume that human capital stock is non-tradable so that while foreign borrowing can be used in the accumulation of physical capital, it cannot be used in the accumulation of human capital. The nontradable nature of the human capital creates a distinction between the capital stocks which is reflected in their relative rates of returns. This distinction, in turn, imposes a borrowing constraint into the economy which solves the infinite convergence rate problem. In our model below, we adopt the approach and introduce a non-tradable investment good into the framework in the fashion of Barro et. al (ibid) in order to overcome the problematic features of the open economy version of the Ramsey growth model.

[2]In fact, Jadayev (2007) shows that capital account openness reduce the share of labor's income in the firm, and at a larger scale, in the economy-wide level, its share in national output.

## 3. The Model

This section introduces the model environment, the assumptions about household preferences and production technologies. A small open economy with three production sectors is described.[3] Production takes place in the non-tradables sector, the tradables sector and the home-services sector. Firms in all three sectors are perfectly competitive in both goods and factors markets. Each sector uses three factors of production: physical capital, human capital, and labor (a non-reproducable factor). The home-services sector produces both a consumption good for the domestic market and an accumulable good such as education that adds to human capital. The non-tradables sector produces for the domestic market, and the price of the good is determined domestically. The tradables sector produces for the international market, and the price of the good is the exogenously given world price. Labor, physical capital and human capital are perfectly mobile across all sectors; and the prices of these factors are determined in competitive markets. The households are the owners of the three factors of production, and they rent these factors of production to firms at competitive rental prices. Each factor is paid its marginal product. There is no mobility of labor and human capital across countries.

There is a representative infinitely-lived, Ramsey household who consumes and realizes expenditures on all three types of consumption goods: home-services, a tradable good and a non-tradable good. The representative household faces a two-stage consumption choice problem: an intertemporal problem and an intra-temporal problem. In the intertemporal problem, the household chooses the optimal consumption and saving at each point in time in order to maximize the present value of her discounted intertemporal utility, $U$, subject to her intertemporal budget constraint. The preferences of the household are represented by the utility function

$$U = \int_0^{\infty} \frac{c(t)^{1-\theta} - 1}{1-\theta} e^{-\rho t} dt \tag{1}$$

where at time $t$, $c(t)$ is an index of intratemporal consumption composite per capita, $1/\theta$ is the elasticity of intertemporal substitution, and $\rho$ is the time preference rate.

The household owns labor, physical and human capital, and also has an outstanding net foreign debt stock of $d$ in per capita terms. Household receives wages for labor services, and rents physical and human capital at $R_k$ and $R_h$, respectively. The household pays interest rate $r$ on outstanding foreign debt, and this interest rate is world-determined. Since physical capital can also be financed by foreign debt, its rate of return, $R_k$, is determined in the international financial market. Thus, the net return on physical capital is equal to the constant world interest rate at all points in time ($R_k = r$). The household spends income from labor and the two types of capital on consumption expenditures $E(c, p)$ and accumulation of physical and human capital. The household also incurs new debt at a given point in time by $\dot{d}$. Then, the household's budget constraint is written as follows[4]

$$\dot{h} + \dot{k} = w + R_k k + R_h h + \dot{d} - rd - E(c, p) \tag{2}$$

[3] A more detailed treatment of the 3-sector Ramsey growth model with extensions can be found in Roe, et al. (2010).

[4] For ease of notation, the time argument $t$ has been dropped.

In the intratemporal problem, at each period in time the representative household chooses consumption bundles of three type of goods so as to minimize its per period expenditures, given its instantaneous consumption composite, $c$. The instantaneous consumption composite of the representative household is of Cobb-Douglas form:

$$c = Bc_1^{\lambda_1} c_2^{\lambda_2} c_3^{\lambda_3} \tag{3}$$

$$c_1 > 0$$

$$c_2 > 0$$

$$c_3 > 0$$

where $c_j$ is the consumption of good $j$, $j = 1,2,3$, $B > 0$ is a constant[5], and $\lambda_1 + \lambda_2 + \lambda_3 = 1$. Given the prices $p = (p_1, p_2, p_3)$ and aggregate consumption $c$, the minimized total expenditures are

$$E(c, p) = \mu(p)c \tag{4}$$

$$\mu(p) = p_1^{\lambda_1} p_2^{\lambda_2} p_3^{\lambda_3}$$

where $\mu(p)$ is the domestic price index. Accordingly, the conditional demands for each consumption item are:

$$c_1 = \frac{\partial E(c, p)}{\partial p_1} = \frac{\lambda_1 E(c, p)}{p_1} \tag{5}$$

$$c_2 = \frac{\partial E(c, p)}{\partial p_2} = \frac{\lambda_2 E(c, p)}{p_2} \tag{6}$$

$$c_3 = \frac{\partial E(c, p)}{\partial p_3} = \frac{\lambda_3 E(c, p)}{p_3} \tag{7}$$

We now specify the production parameters of the modeled economy in detail. In particular, the production functions of the firms representing each sector are of the constant-returns-to-scale, Cobb-Douglas type. The production of the non-tradables sector firm, the tradables sector firm and the home-services sector firms are represented respectively by

$$Y_1 = a_1 A_1 L_1^{\alpha_1} K_1^{\alpha_2} H_1^{\alpha_3} \tag{8}$$

$$Y_2 = a_2 A_2 L_2^{\beta_1} K_2^{\beta_2} H_2^{\beta_3} \tag{9}$$

$$Y_3 = a_3 A_3 L_3^{\delta_1} K_3^{\delta_2} H_3^{\delta_3} \tag{10}$$

Here, $a_j, A_j > 0$ , $j = 1,2,3,$ are the scaling constants in the non-tradables, tradables and home services sector production functions, and $\alpha_1, \alpha_2, \alpha_3 \in (0,1), \beta_1, \beta_2, \beta_3 \in (0,1)$, $\delta_1, \delta_2, \delta_3 \in (0,1)$; and $\sum_{i=1}^{3} \alpha_i = 1$, $\sum_{i=1}^{3} \beta_i = 1$, $\sum_{i=1}^{3} \delta_i = 1$.

### *3.1 The open economy with partial capital mobility*

The economy is open to international capital flows, hence households are allowed to borrow from abroad to finance consumption or saving. It is assumed that the country is small compared to the rest of the world and the world is in steady state. In such an environment the

[5]For algebraic simplicity, the scale parameter $B$ is set at $B \equiv \lambda_1^{-\lambda_1} \lambda_2^{-\lambda_2} \lambda_3^{-\lambda_3}$.

financial integration can take two forms. It can either allow for perfect capital mobility or it can restrict the capital mobility between countries.

As has already been discussed above, allowing for perfect capital mobility leads to certain problematic results in a Ramsey-type growth model. Obstfeld (1998) notes that open capital accounts enable the financial investors to borrow from the economies with low interest rates and lend in the economies with high interest rates. These types of transactions lead to the equalization of the interest rates in financial markets. Thus, a common world interest rate is obtained eventually and the domestic country in question would face a constant world interest rate. As noted in Barro and Sala-i-Martin (2004), since the returns on both kinds of capital would also be equal to this constant world interest rate this would cause the per capita values of physical capital, human capital and aggregate output to be constant during the transition. Thus, in the open economy version of the Ramsey model, the endogenous variables jump to their steady state values at once. The counterfactual results stem from the infinite convergence rates of the variables.

According to Gourinchas and Jeanne (2002), the economies that experience instantaneous convergence by financial integration are, in fact, close to their conditional steady states. As discussed in Mankiw et al. (1992), this closeness might result from a low capital share in production which causes the diminishing returns to capital to set in more quickly. Introducing human capital into the model, they are able to slow down the diminishing returns to capital. In fact, Barro et al. (1995) argue that the inclusion of human capital makes the production function less concave compared to the case when there is only one type of capital stock in the economy. However, in the framework of perfect capital mobility, even though the capital share is increased by introducing human capital, it is not sufficient to eliminate the aforementioned problems of open economy Ramsey Model.

One of the remedies of infinite convergence is to allow for constrained capital mobility instead of perfect capital mobility. In this model, we assume that there is a borrowing constraint that imposes a restriction on the amount of foreign debt available to the economy: In order to be able to borrow from abroad, domestic households must provide a collateral against the amount borrowed. We assume that only physical capital can serve as collateral against foreign borrowing, and hence the amount of foreign debt, $d$, cannot exceed the available physical capital stock, $k$. Following Barro et al. (1992, 1995) and Barro and Sala-i-Martin (2004), it is assumed that this constraint is binding, $d = k$.[6] This borrowing constraint brings about the asymmetry between the two types of capital; physical capital can be used as a colleteral against foreign debt, while human capital cannot. This is a direct implication of the assumption that foreigners cannot own domestic human capital, and that there is no international mobility of labor (Barro et al., 1992). Since only physical capital can be used as collateral, a change in foreign debt can only be brought about by a change in domestic physical capital stock; therefore the borrowing condition requires that $\dot{d} = \dot{k}$ at each point in time, as well. However here one must be careful about the distinction between $k$ and $h$: as stated in Barro et al. (ibid.), the distinction between these two types of capital does not necessarily stem from their physical characteristics, but rather whether the cumulated goods

[6]Since only physical capital can be used as collateral against foreign debt the condition $d \leq k$ should hold. In the original paper, Barro et al. (1992) discuss the role of initial asset values in determining whether the constraint should be binding or not. They note that if the constraint is not binding, then the economy will continue to suffer from infinite convergence speed. If the initial conditions are assumed to satisfy $k(0) + h(0) - d(0) < h^*$, the constraint is binding, and the physical capital market clearing condition becomes $d = k$.

can be used as a collateral for debt in international markets. Accordingly, the $k$ in the model is likely to be much smaller than the actual physical capital stock in the economy.

Under the constraints described above, the household's intertemporal budget constraint (2) takes the form

$$\dot{h} = w + R_h h - E(c, p) \quad (11)$$

The competitive equilibrium in the open economy with partial capital mobility can be defined as follows:

**Definition 1** *A competitive equilibrium for this economy is a list of sequences of household consumption plans* $\{c_1(t), c_2(t), c_3(t)\}_{t=0}^{\infty}$, *production plans* $\{y_1(t), y_2(t), y_3(t)\}_{t=0}^{\infty}$, *output prices* $\{p_1(t), p_2(t), p_3(t)\}_{t=0}^{\infty}$, *factor rental prices* $\{w(t), R_h(t)\}_{t=0}^{\infty}$, *and an initial condition for human capital* $h(0) < h^*$ *such that*

1. given $h(0)$, output prices and factor rental prices, the sequence $\{c_1(t), c_2(t), c_3(t)\}_{t=0}^{\infty}$ minimizes the representative household's per period expenditures and maximizes the present value of discounted intertemporal utility;
2. given $h(0)$, output prices and factor rental prices, the representative firm in each sector $i$, $i = 1,2,3$ produces $\{y_i\}_{t=0}^{\infty}$ and maximize profits;
3. raw labor market clears;
4. human capital market clears;
5. international borrowing constraint holds, $d = k$;
6. home-services market clears;
7. non-tradable goods market clears.

The model above assumes that the markets for non-tradables and home-services clear within the domestic economy so that there is no international trade taking place associated with these goods or services. On the other hand, the tradable goods sector is open to international trade and international capital flows; therefore, the sector incorporates exported goods, imported goods and foreign capital. Under Walras' Law, we require that the balance of payments is satisifed at each point in time. Since the amount of foreign debt is equal to the quantity of physical capital at each point in time, the change in capital stock will be matched by a change in foreign debt. Furthermore, the model allows for the situation that the small country runs a trade deficit (borrows indefinitely at steady state, $d = k > 0$) at international markets.

### *3.1.1 Characteristics of the equilibrium in partial capital mobility economy*

The firms in each sector face the problem of minimizing their costs and maximizing their profits at each point in time given output and input prices. When the cost minimizing values of factors of production are obtained, they will be used in the profit maximization problem so as to find the profit maximizing level of output in each sector. At the point of profit maximization, in each sector, unit price of the respective product must be equal to the marginal cost in each sector:

$$p_1 = MC_1(w, r, R_h) = \frac{1}{a_1} w^{\alpha_1} r^{\alpha_2} R_h^{1-\alpha_1-\alpha_2} \quad (12)$$

$$p_2 = MC_2(w, r, R_h) = \frac{1}{a_2} w^{\beta_1} r^{\beta_2} R_h^{1-\beta_1-\beta_2} \tag{13}$$

$$p_3 = MC_3(w, r, R_h) = \frac{1}{a_3} w^{\delta_1} r^{\delta_2} R_h^{1-\delta_1-\delta_2} \tag{14}$$

where $MC_i$ denotes the marginal cost in sector $i$ and $r$ is the world interest rate which is assumed to be constant at its steady state value, $r = \rho$. Particularly, tradable good price is the world price, and we set it as the numeraire, hence $p_2 \equiv 1$ in the model. Using the profit maximization conditions (12)-(14), with $r = \rho$, we can obtain wages, human capital rental rate and non-tradables prices as functions of home services prices:

$$\omega = \mathbf{w}(p_3) \tag{15}$$

$$R_h = \mathbf{R}_h(p_3) \tag{16}$$

$$p_1 = \mathbf{p}_1(p_3) \tag{17}$$

At the competitive equilibrium, the markets for the sectors which are close to international trade in goods and services clear within the domestic economy. The market clearing condition for the non-tradables sector is

$$c_1 + \dot{k}^{dom} = y_1 \tag{18}$$

or,

$$\lambda_1 \mu(p) c + p_1 \dot{k}^{dom} = y_1 p_1 \tag{19}$$

Here, $\dot{k}^{dom}$ represents the investment in domestic capital goods, i.e. the part of accumulation in physical capital contributed by domestic investment goods.

In the home-services sector, the output of the sector is used for consumption purposes and also in the accumulation of human capital (i.e., education). Therefore, the market clearing condition for the home services sector is given by

$$\frac{\partial E(c, p)}{\partial p_3} + \dot{h} = y_3 \tag{20}$$

$$\lambda_3 \mu(p) c + p_3 \dot{h} = p_3 y_3 \tag{21}$$

Rearranging these two goods market clearing conditions, we obtain

$$y_3 = (y_1 - \dot{k}^{dom}) \frac{\mathbf{p}_1(p_3, r)}{p_3} \frac{\lambda_3}{\lambda_1} + \dot{h} \tag{22}$$

which provides us with a representation of the home services sector output per capita in terms of non-tradables sector output per capita.

Raw labor market and human capital market clearing conditions are linear in each sector's per capita output levels $y_1$, $y_2$ and $y_3$:

$$\frac{\partial MC_1(w, r, R_h)}{\partial w} y_1 + \frac{\partial MC_2(w, r, R_h)}{\partial w} y_2 + \frac{\partial MC_3(w, r, R_h)}{\partial w} y_3 = 1 \tag{23}$$

$$\frac{\partial MC_1(w, r, R_h)}{\partial R_h} y_1 + \frac{\partial MC_2(w, r, R_h)}{\partial R_h} y_2 + \frac{\partial MC_3(w, r, R_h)}{\partial R_h} y_3 = h \tag{24}$$

Combining (23), (24), (22), and (11), one can derive $y_1$ and $y_2$ as functions of $p_3$ and $h$:

$$y_1 = \mathbf{y}_1(p_3, h) \tag{25}$$

$$y_2 = \mathbf{y}_3(p_3, h) \tag{26}$$

Once $y_1$ is derived, $y_3$ expression can be obtained from (22).

Characterization of the steady state equilibrium requires that in per capita terms, all endogenous variables of the economy grow at their constant long run growth rates. In this case, for simplicity, we rule out any positive long run growth (i.e. any population growth or technological progress), hence at the steady state equilibrium we require

$$\dot{h} = 0$$

$$\dot{k}^{dom} = 0$$

$$\dot{c} = 0$$

$$\dot{p}_1 = 0$$

$$\dot{p}_3 = 0$$

Solution to the intertemporal problem of the representative household yields the Euler equation, or the Ramsey rule for optimal saving in simplified form: [7]

$$\frac{\dot{c}}{c} = \frac{1}{\theta}[R_h - \rho - \lambda_1 \frac{\dot{p}_1}{p_1} - \lambda_3 \frac{\dot{p}_3}{p_3}] \tag{27}$$

Since the steady state requires $\dot{p}_1 = \dot{p}_3 = 0,$ and also $\dot{c} = 0,$ from the Euler equation, it must be the case that

$$R_{h,ss} = \rho \tag{28}$$

at the steady state. Given the value of the interest rate at the steady state, using (15), (16), and (17), steady state values of wage rate ($w_{ss}$), relative price of non-tradables ($p_{1,ss}$) and the relative price of home services ($p_{3,ss}$) can be found. Plugging in these steady state values into the factor market clearing conditions (23) and (24), the raw labor and human capital market clearing conditions can be written at the steady state. From these two conditions, after appropriate substitutions, steady state values of $y_{1,ss}$, $y_{2,ss}$ and $y_{3,ss}$ are obtained as functions of $h_{ss}$ (the steady state value of $h$).

At the steady state, the intertemporal budget constraint of the household becomes (with

$$0 = w_{ss} + \rho h_{ss} - E(c_{ss}, p_{ss}) \tag{29}$$

where $h_{ss}$ is the steady state value of human capital per capita, and $c_{ss}$ is the steady state value of consumption composite per capita. From (29), we solve for

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[7] The Euler equation from the intertemporal problem is obtained as

$$\frac{\dot{c}}{c} = \frac{1}{\theta}[R_h - \rho - (\lambda_1 \frac{\dot{p}_1}{p_1} + \lambda_2 \frac{\dot{p}_2}{p_2} + \lambda_3 \frac{\dot{p}_3}{p_3})]$$

The Euler equation is further simplified since the world price of tradable good $p_2$ is taken exogenously, thus $\frac{\dot{p}_2}{p_2} = 0.$

$$c_{ss} = \mathbf{c}(h_{ss})$$

All endogenous variables are found to be functions of $h_{ss}$ at the steady state. Hence, finding the steady state solutions boils down to finding the value of $h_{ss}$. To this end, either the non-tradable goods market clearing condition or the home services market clearing condition can be utilized. Solution to either of them would lead to the same $h_{ss}$ value. The equation (18) represents the non-tradable goods market clearing condition. At the steady state, there is no change in the domestic physical capital stock; therefore $\dot{k}^{dom} = 0$. As a result, the market clearing condition becomes

$$c_1(h_{ss}) = y_1(h_{ss}) \tag{30}$$

$$\lambda_1 \mathbf{c}(h_{ss})(p_{1,ss})^{\lambda_1}(p_2)^{\lambda_2}(p_{3,ss})^{\lambda_3} = y_1(h_{ss})p_{1,ss} \tag{31}$$

where $p_2 = 1$. From (31), $h_{ss}$ can be obtained, and once $h_{ss}$ is obtained, the remaining endogenous variable values of the model can be found, as well.

### *3.2 The closed economy with no capital mobility*

We now introduce the economy with no capital mobility with the restriction that $d = \dot{d} = 0$. In this environment, households can borrow or lend at the domestic markets at some interest rate $R$, but are not allowed to hold foreign debt. Otherwise the model environment is the same as the environment described above. Under $d = \dot{d} = 0$, the household's intertemporal budget constraint becomes

$$\dot{h} + \dot{k} = w + R_k k + R_h h - E(c, p) \tag{32}$$

Since the representative household can accumulate two different types of capital, in equilibrium, the household will be indifferent between them, that is, the household will equate the rates of return on the two types of capital to the domestic borrowing and lending rate, $R$. Equality of the rates of return on the two types of capital, i.e.

$$R_k = R_h = R$$

in each sector requires

$$\alpha_2 \frac{Y_1}{K_1} = (1 - \alpha_1 - \alpha_2)\frac{Y_1}{H_1}$$

$$\beta_2 \frac{Y_2}{K_2} = (1 - \beta_1 - \beta_2)\frac{Y_2}{H_2}$$

$$\delta_2 \frac{Y_3}{K_3} = (1 - \delta_1 - \delta_2)\frac{Y_3}{H_3}$$

that is, in each of the sectors, physical-to-human capital shares are constant:

$$\frac{K_1}{H_1} = \frac{\alpha_2}{1 - \alpha_1 - \alpha_2} \; non - tradable ss ector \tag{33}$$

$$\frac{K_2}{H_2} = \frac{\beta_2}{1 - \beta_1 - \beta_2} \; tradable ss ector \tag{34}$$

$$\frac{K_3}{H_3} = \frac{\delta_2}{1 - \delta_1 - \delta_2} \; home - services sector \tag{35}$$

Since the two types of capital have the same rates or return, one can define a broad capital in each sector to include both types of capital, $Z_i \equiv K_i + H_i$, in sector $i$. Then, in the non-tradables sector;

$$Z_1 = \frac{\alpha_2}{1-\alpha_1-\alpha_2} H_1 + H_1$$

$$= \frac{1-\alpha_1}{1-\alpha_1-\alpha_2} H_1;$$

$$H_1 = \frac{1-\alpha_1-\alpha_2}{1-\alpha_1} Z_1; K_1 = \frac{\alpha_2}{1-\alpha_1} Z_1$$

$$Y_1 = \widetilde{A}_1 L_1^{\alpha_1} Z_1^{1-\alpha_1} \tag{36}$$

in the tradables sector;

$$Z_2 = \frac{\beta_2}{1-\beta_1-\beta_2} H_2 + H_2$$

$$= \frac{1-\beta_1}{1-\beta_1-\beta_2} H_2;$$

$$H_2 = \frac{1-\beta_1-\beta_2}{1-\beta_1} Z_2; K_2 = \frac{\beta_2}{1-\beta_1} Z_2$$

$$Y_2 = \widetilde{A}_2 L_2^{\beta_1} Z_2^{1-\beta_1} \tag{37}$$

and in the home-services sector;

$$Z_3 = \frac{\delta_2}{1-\delta_1-\delta_2} H_3 + H_3$$

$$= \frac{1-\delta_1}{1-\delta_1-\delta_2} H_3;$$

$$H_3 = \frac{1-\delta_1-\delta_2}{1-\delta_1} Z_3; K_3 = \frac{\delta_2}{1-\delta_1} Z_3$$

$$Y_3 = \widetilde{A}_3 L_3^{\delta_1} Z_3^{1-\delta_1} \tag{38}$$

Since the household will be indifferent in terms of holding physical or human capital types, we can define a broad capital stock per capita to encompass both types of capital, $z \equiv k + h$ (Barro et al., 1992). As such, the household's intertemporal budget constraint can be rewritten as

$$\dot{z} = w + rz - E(c, p) \tag{39}$$

Below, we define the competitive equilibrium for the non- capital mobility economy model:

**Definition 2** *A competitive equilibrium for this economy is a list of sequences of household consumption plans* $\{c_1(t), c_2(t), c_3(t)\}_{t=0}^{\infty}$, *production plans* $\{y_1(t), y_2(t), y_3(t)\}_{t=0}^{\infty}$, *output prices* $\{p_1(t), p_2(t), p_3(t)\}_{t=0}^{\infty}$, *factor rental prices* $\{w(t), R(t)\}_{t=0}^{\infty}$, *and an initial condition for broad capital* $z(0) < z_0$ *such that*

1. given $z_0$, output prices and factor rental prices, the sequence $\{c_1(t), c_2(t), c_3(t)\}_{t=0}^{\infty}$ minimizes the representative household's per period expenditures and maximizes the present value of discounted intertemporal utility;

2. given $z_0$, output prices and factor rental prices, representative firm in each sector $i$, $i = 1,2,3$ produces $\{y_i\}_{t=0}^{\infty}$ and maximize profits;

3. raw labor market clears;

4. broad capital market clears;

5. home-services market clears;

6. non-tradable goods market clears.

The model above assumes that the markets for non-tradable goods and home-services clear within the domestic economy so that there is no international trade taking place associated with these goods or services. On the other hand, the tradable-goods sector is open to international trade; therefore, the sector incorporates both export goods and import goods. This condition requires the trade balance to take place in tradable goods sector since there is no borrowing or lending at international level. Consequently, any excess supply or demand in exported goods must be matched by an excess demand or supply in imported goods within the tradable goods sector.

*3.2.1 Characteristics of the equilibrium in no capital mobility economy*

Same as in the economy with partial capital mobility, firms in an economy with no capital mobility minimize cost of production and maximize profits at each point in time given output and factor rental prices in a perfectly competitive environment. Profit maximization in each sector requires that the marginal cost in each sector equals the unit price of the product in each sector:

$$p_1 = MC_1(w,R) = \frac{1}{a_1} w^{\alpha_1} R^{1-\alpha_1} Non-tradable sector \tag{40}$$

$$p_2 = MC_2(w,R) = \frac{1}{a_2} w^{\beta_1} R^{1-\beta_1} Tradable sector \tag{41}$$

$$p_3 = MC_3(w,R) = \frac{1}{a_3} w^{\delta_1} R^{1-\delta_1} Home-services sector \tag{42}$$

where $MC_i$ denote the marginal cost in each sector $i$. Similar as in the economy described in the previous subsection, the price of the tradable good $p_2$ is taken as the world price, and set equal to 1. Accordingly, we can derive the functions for factor rental prices and $p_1$ in terms of $p_3$ as

$$\omega = \mathbf{w}(p_3) \tag{43}$$

$$R = \mathbf{R}(p_3) \tag{44}$$

$$p_1 = \mathbf{P}_1(p_3) \tag{45}$$

Markets for home services and non-tradables clear within the domestic economy. That is, the output of the non-tradables sector is equal to the domestic consumption and domestic physical capital accumulation, $\dot{k}^{dom}$ (here, as in the previous model, $\dot{k}^{dom}$ can be thought of

as the part of new broad capital that is contributed to broad capital stock by accumulation of domestic investment goods):

$$c_1 + \dot{k}^{dom} = y_1 \tag{46}$$

or,

$$\lambda_1 \mu(p) c + p_1 \dot{k}^{dom} = y_1 p_1 \tag{47}$$

In the home-services sector, similar as in the open economy environment, the output of the sector is used for consumption purposes and also in the accumuation of human capital (i.e., education). Therefore, the market claring condition for the home services sector is given by

$$\frac{\partial E(c,p)}{\partial p_3} + \dot{h} = y_3 \tag{48}$$

$$\lambda_3 \mu(p) c + p_3 \dot{h} = p_3 y_3 \tag{49}$$

From these two market clearing conditions (47) and (49), it is obtained that

$$y_3 = (y_1 - \dot{k}^{dom}) \frac{\mathbf{P}_1(p_3)}{p_3} \frac{\lambda_3}{\lambda_1} + \dot{h} \tag{50}$$

Raw labor market and broad capital market clearing conditions are given as

$$\frac{\partial MC_1(w,R)}{\partial w} y_1 + \frac{\partial MC_2(w,R)}{\partial w} y_2 + \frac{\partial MC_3(w,R)}{\partial w} y_3 = 1 \tag{51}$$

$$\frac{\partial MC_1(w,R)}{\partial R} y_1 + \frac{\partial MC_2(w,R)}{\partial R} y_2 + \frac{\partial MC_3(w,R)}{\partial R} y_3 = z \tag{52}$$

Given the factors of market clearing conditions and domestic goods market clearing conditions, one can solve for the output functions in terms of $p_3$ and $z$:

$$y_1 = \mathbf{y}_1(p_3, z) \tag{53}$$

$$y_2 = \mathbf{y}_2(p_3, z) \tag{54}$$

Once $y_1$ is derived, $y_3$ can be obtained from (50).

At the steady state equilibrium, all endogenous variables are constant, and without any population growth or technological progress, it must be true that

$$\dot{z} = 0$$

$$\dot{k}^{dom} = 0$$

$$\dot{c} = 0$$

$$\dot{p}_1 = \dot{p}_3 = 0$$

From the household's intertemporal utility maximization, the Euler equation is given by

$$\frac{\dot{c}}{c} = \frac{1}{\theta}[R - \rho - \lambda_1 \frac{\dot{p}_1}{p_1} - \lambda_3 \frac{\dot{p}_3}{p_3}] \tag{55}$$

Since the steady state requires $\dot{p}_1 = \dot{p}_3 = 0,$ and also $\dot{c} = 0,$ from the household's problem, it must be the case that

$$R_{ss} = \rho \qquad (56)$$

The steady state solution of the model with no capital mobility is similar to that of the model under partial capital mobility, hence we skip the details here.

## 4. Numerical Application

The model's numerical application requires the construction of a 3-sector Social Accounting Matrix (SAM) for economies both, under partial capital mobility and under no capital mobility. In fact, we can think of these two economies as operating under two distinct institutional environments. The model is applied to the Turkish data for the year 2002. For both economies, initial values from the model reproduce 2002 data. The data are drawn from the Turkish Input-output tables for 2002, and also from the National Accounts and employment statistics of the Turkish Statistical Institute (TURKSTAT).[8]

### *4.1 Parameter Specification*

The production sectors included in the SAM are the non-tradables, tradables and the home-services sectors. Table 1 provides the production value and sectoral shares of production in total GDP for 2002.

As Table 1 denotes, the home services sector dominates the aggregate production in the economy by providing 55.3 percent of the total output. The home services production is allocated to domestic consumption of services, as well as to education, or in other words accumulation of human capital. The output supply of tradables is given by the share of exports in the total GDP, and is obtained from the Input-output Table for the Turkish economy for 2002. This item in the GDP contains the value of all types of exported goods, belonging to either agricultural or to manufacturing sectors, and can be a consumable or an investment good. Non-tradables, on the other hand, again belong to either agricultural or manufacturing sectors, but contain part of domestic agricultural or manufacturing production that is not exported.

In 2002, we know that about 4 percent of GDP has been allocated to expenditures on education, which is about 7.2 percent of total services production. This implies that the remaining 149,829,353,000TL worth of home services production has been consumed by households, which is 69 percent of total household consumption expenditures (Table 2). Tradable goods consumption makes up for the second largest share in household expenditures. Here we first need to realize that from the demand side, tradable goods are imported goods, consisting of both consumables and capital goods. Secondly, we know that gross fixed capital formation in 2002 was 61,728,381,000TL. As shown in Table 3, about 20 percent of gross fixed capital formation is due to imported capital. If 12,567,860,000TL worth of tradables is imported capital, then the remaining 51,970,508,000 TL worth of tradables is consumed by households,[9] which is 24 percent of overall consumption expenditures. Lastly, we have already mentioned that 20 percent of gross fixed capital formation is due to imported capital, then the remaining 80 percent must be supported by investment in domestic physical capital, which is part of non-tradables. Since total supply of non-tradables must be equal to total domestic demand of non-tradables, and since part of this domestic demand is investment, the remaining supply of non-tradables is allocated to household consumption, which constitutes 7.1 percent of overall household consumption expenditures.

[8]The reason we have chosen the year 2002 is because of the fact that for the Turkish Input-output tables, 2002 is the last available year.

[9]Initially in the SAM, value of imports is assumed to be equal to value of exports.

Table 4 summarizes the sectoral allocation of total employment. It is found that in 2002, the majority of the employment was concentrated in the home-services sector with about 55 percent of the total. It is followed by the tradables sector which makes up for nearly 27 percent of total employment. Compared to these two sectors, the labor allocation in the non-tradables sector stands at about 19 percent. The total work force statistics are taken from the TURKSTAT data on employment, and sectoral shares are calculated from sectoral worker compensation data drawn from Input-output tables for the year 2002.

The production technology in each sector is given by relative factor elasticities of labor and capital in each model. In terms of capital use, production sectors under the model with partial capital mobility use a more disaggregated capital with human capital and physical capital components, while the production sectors under the model without capital mobility utilize a broad capital. In that sense, we specify the production parameters of each model separately.

In calculating the factor elasticities in each sector, we make use of profit maximization conditions for a perfectly competitive firm. The production technology of each sector is of Cobb-Douglas form and exhibit constant returns to scale. Based on these characteristics, profit maximization conditions demonstrate that factor elasticities are given by the initial shares of factor payments in total value of production in each sector. For example, the elasticity of raw labor in home services production is found by dividing the payments to raw labor in that sector (i.e. total worker compensation) by the value of that sector's output. We first realize this in the partial capital mobility model, since there is a common rental rate for physical capital (i.e. the world interest rate which is constant), it must be the case that for all sectors

$$\frac{k_1}{y_1} = \frac{k_2}{y_2} = \frac{k_3}{y_3} = \frac{k}{y} \tag{57}$$

the capital output ratio is the same as the economy-wide capital output ratio, and it is consant throughout. Secondly, in order to satisfy Walras' Law, it must be the case that the payments to foreign debt $rd$ must be equal to $\dot{k}$, the accumulation of physical capital, or the consumption of fixed capital. Since $d = k$, it is also the case that $rd = rk$, and hence $k = \frac{\dot{k}}{r}$. Given $k$, in the overall economy, $\frac{rk}{y}$ ratio is obtained as 0.21, which must be the same in all seperate sectors by (57)[10]. Hence, we fix the physical capital elasticity of production in all sectors as 21 percent. The residual in total production value after accounting for payments to raw labor and payments to physical capital, is then the payments to human capital.[11] Accordingly, tradable goods sector is labor intensive, while the non-tradable goods sector is human capital intensive. In fact, in the composition of tradable goods, agricultural goods and manufacturing products using labor intensive technologies such as textiles constitute a relatively large fraction. From the human capital intensiveness of the non-tradable sector, we can deduce that this sector uses more of the capital goods that are not used as a colleteral in international capital markets.

[10]This corresponds to $k/y = 5$.

[11]Note that we have already mentioned that here the distinction between physical and human capital do not necessarily stem from their physical nature, but rather whether the capital can be used as a collateral against foreign debt. Here the payments to human capital seem much larger than the payments to physical capital simply because of the fact that the stock of capital which can not used as a collateral against foreign debt is larger in amount.

While the production sectors in the partial capital mobility model use a more disaggregated form of capital, in the model without capital mobility, we use broad capital which is composed of both capital types.

As is indicated in Table 6, the relative factor elasticities point to the fact that the tradables sector produces the most labor intensive goods since it has the highest labor intensity, as mentioned above. On the other hand, the non-tradable goods sector produces the most broad capital intensive goods and it has the highest broad capital intensity. Compared to these two sectors, the home-services sector has a middle position with relatively more labor intensiveness than the non-tradables sector and relatively more broad capital intensiveness than the tradables sector.

Below we present the common parameters in both models in Table 7:

In order to be able to obtain comparable results, we keep the consumption parameters and thus the consumption behavior of the household the same across the two environments, we only change the production structure as given in Tables 5 and 6. If we were to change the consumption behavior as well, we would not be able to isolate the effect of the changes in the capital mobility and thus the capital market on demand and production. In the model, elasticity of intertemporal substitution and the time preference rate are taken exogenously, which is a common practice in the literature. Particularly, a value of 0.042 for the time preference rate (for example see Saracoglu, 2008) corresponds to a discount rate of about 95 percent, which is a common value in the literature. [12]

### *4.2 Numerical Results*

Numerical solutions from the models will be presented as the baseline simulation results and steady state equilibrium results. We first present the results from the more comprehensive model of partial capital mobility, and then restrict the model to the non- capital mobility case according to the constraint $d = \dot{d} = 0$, and compare and constrast the steady state equilibrium results from both model environments.

#### *4.2.1 Results from the open economy model with partial capital mobility*

We first present the results from the more comprehensive model, the open economy with partial capital mobility. In Table 8 and Table 9, main results of the model are given.

Towards steady state, the economy experiences human capital accumulation and a corresponding decline in the rental rate of human capital. This accumulation has an impact on sectoral production and factor allocation through two channels. On the demand side, the capital accumulation experienced in the open economy model leads to improvements in labor productivity in each sector. As a result of higher productivity, labor wages increase, from 92,39 to 142,37 billion TL. Higher wages and thus higher income of households induce increased expenditure on all goods and services, from nearly 216 to 331 billion TL. While the level of consumption for each good and service rises, the shares in total expenditure remain constant, due to the homothetic nature of the utility function. Despite the constant shares of consumption expenditure, the increase in the consumption levels of households indicates a rising domestic demand. The rise in domesic demand brings about a change in relative prices.

On the supply side, it is observed that the most human capital intensive sector is the non-tradable goods sector. Thus, a decline in the rental rate of human capital decreases the marginal cost in this sector more than the other two sectors. With this drop in marginal cost,

[12]For example, one can refer to King and Rebelo (1993) for the treatment of exogenous preference parameters in dynamic general equilibrium models. It is possible that one can also perform sensitivity analysis to examine how the model's results are affected from varying preference parameters, however for the time being, it is not the primary focus of the paper.

in equilibrium the price of the non-tradable goods declines, as well. The second most human capital intensive sector is the home-services sector which, by the same reasoning, experiences a decline in output prices relative to the other sectors. In short, the prices of the products of non-tradable goods and home-services sectors decline, while that of tradable-goods sector stays constant towards steady state. Thus, the price of tradable-goods is higher relative to the other two sectors which makes production in tradable-goods sector more profitable compared to the other two sectors. This relative profitability pulls resources towards this sector and brings about an increase in production, and the share of the sectoral output in GDP starts to rise towards the steady state from 22.2 percent to 40 percent. On the contrary, the share of sectoral output of non-tradable goods and home-service sectors decline over time. Given these changes in prices and, thereby profitability and production shares, both raw labor and physical capital are pulled out of non-tradables and home-services sectors to be allocated in the tradables sector. Human capital, on the other hand, flows from non-tradables sector mainly towards tradables sector; there is only a slight increase in home-services' human capital share.

Even though the production shares decline in two sectors, it can be seen from Table 8 that the decline in non-tradables sector, from 22.5 percent to 5.7 percent, is much more severe than that of the home-services sector, from 55.3 percent to only 54.3 percent. Thus, most of the factor reallocation occurs between the non-tradable goods and the tradable goods sectors. We can conclude that in the partial capital mobility model, the importance of the tradable goods sector increases in production by utilizing the factors that leave the non-tradable goods sector.

In addition to human capital accumulation, the open economy model experiences some degree of accumulation of physical capital, made possible through foreign borrowing. Given that the rate of return on physical capital remains constant, it is counter-intuitive to observe an increase in physical capital stock over time. As is recognized in Barro, et al. (1995), there are two factors at force which lead to this increase. One of the reasons is the fact that in each sector, physical capital to output ratio, $k/y$, remains constant (at about 5), since the rate of return on physical capital is pegged against a constant interest rate. This constancy requires that in each sector, physical capital per worker is growing at the same rate as output per worker as can be seen on Table 8.[13] As income grows, physical capital accumulates also (at about 44 percent each in steady state).

[13]The steady state results demonstrate that each sector's production share in total output is equal to their respective sectoral physical capital shares in total physical capital. This equality is another result of the constancy in $k/y$ ratio in each sector. The causality can be shown by the following derivation. We know that

$$\frac{k_1}{y_1} = \frac{k_2}{y_2} = \frac{k_3}{y_3} = \frac{k}{y}$$

If we generalize the equality we have,

$$\frac{rK_i}{P_i Y_i} = \frac{rK}{GDP}$$

where i=1,2,3. Taking the inverse of both sides we have,

$$\frac{P_i Y_i}{rK_i} = \frac{GDP}{rK}$$

$$\frac{P_i Y_i}{GDP} = \frac{rK_i}{rK}$$

Thus, the left-hand side of the equality gives us the production shares of each sector in GDP, while the right-hand side gives the sectoral physical capital as a share of total physical capital

The second reason behind the gradual increase in physical capital stock is related with the requirements of the production functions in each sector. According to Barro et al. (1995), since the accumulation of human capital is restricted by domestic saving and the production function necessitates a complementary relationship between human and physical capital in production, the occurrence of a gradually increasing physical capital stock is not that counter-intuitive. The non-tradable nature of the human capital stock limits its accumulation so that it cannot jump to its steady state amount instantaneously. Hence lower values of human capital stock is observable in the initial periods. Since the production function includes both $k$ and $h$, the low human capital stock value affects the marginal product of physical capital such that $k$ is lower than its steady state amount. However, based on the assumption that physical capital is financed by foreign debt, it should have converged to the steady state amount instead of being lower than it as is discussed in Barro et al. (ibid.) Nonetheless, the low amount of human capital intervenes with the instantenous convergence of physical capital stock. As human capital stock increases over time to its steady state, the marginal product of physical capital also rises which brings about an increase in $k$. Consequently, the borrowing constraint on the economy leads to a gradual increase in physical capital per capita. Although the rate of return on physical capital is constant, due to albeit slight accumulation, there is an increase in the earnings from physical capital, from 61,73 to 89,2 billion TL.

Even though the partial capital mobility model has both physical and human capital accumulation towards the steady state, they accumulate at different paces. In fact, the transitional behavior of $h/k$ ratio gives much information about the pace of convergence in the open economy framework. According to the values on Table 8, it can be seen that the $h/k$ ratio increases over time in each sector. The highest $h/k$ ratio at the steady state is recognized in the non-tradable goods sector, from 1.64 to 2.47. The rise in $h/k$ ratio brings about a higher impact of diminishing returns. That is, the increase in human capital leads to a faster realization of diminishing returns in the economy which also raises the speed of convergence with a finite pace. Thus, the infinite convergence problem of the open economy models is solved by the non-tradable nature of the human capital stock.

Given the above discussion, we know that physical and human capital accumulation leads to many changes in the production pattern and factor allocation in the open economy environment. Moreover, it is known that physical capital accumulation brings about an increase in the earnings from physical capital which are, in fact, the payments abroad. Therefore, higher earnings means an increased amount of debt payments. Now, the economy also faces the question how the rising debt should be paid back. Following the factor reallocation across sectors, the production pattern is changed in such a way that the economy puts higher emphasis on the production of tradables, much less on non-tradables, and slightly less on home services production. One important implication from this outcome is that the economy can pay its rising debt back mainly by exporting abroad (in any case, the two other sectors are domestic sectors). Yet, the tradable-goods sector is the most labor-intensive sector in the economy. Thus, the presence of partial capital flows leads to such a factor re-allocation in the economy that total production is dominated by the most labor-intensive sector the revenues of which will be utilized in debt payment. That is, the open economy will pay its debt abroad by excess earnings in tradable-goods which means production pattern turns more and more to labor-intensive goods.

#### *4.2.2 Results from the closed economy model without capital mobility*

The closed economy without capital mobility is differentiated from the open economy with partial mobility in the sense that now foreign debt is equal to zero, and the interest rate is determined within the economy (Tables 10 and 11). This brings about the fact that all capital

(a composite of human and physical capital types, i.e. broad capital) accumulate by domestic means (although pyhsical capital may be imported, still by domestic means).

In the closed economy, the production pattern follows the domestic demand pattern towards the steady-state equilibrium: one can say that production is purely demand-driven. In this environment, with capital deepening, factor reallocation occurs between the two domestic sectors, non-tradables and home services: labor and capital are pulled out of non-tradables into home-services to compensate for the relative increase in demand share in home-services. In this economy, relative prices of both domestic goods decline as both production modes are relatively more capital intensive. As the rental price of capital declines towards the steady state, marginal cost of production also declines which leads to a concomitant decline in unit prices in both of these sectors. The relative price of the tradable good remains relatively high (at 1) compared to the other sectors' prices, thus, despite the fact that it is the most labor intensive sector among all sectors (and least capital intensive) it does not lose labor and capital to other sectors by maintating competitiveness and profitability (one would expect flight of labor as labor becomes more expensive and flight of capital as capital becomes less expensive in the long-run).

While the economy converges to its steady state, broad capital is accumulated throughout the transition period. This capital accumulation ensures that each worker is equipped with more capital in each sector which leads to a rise in labor productivity. As a result of higher productivity, labor wages are increased from 92,39 to 178,6 billion TL, which is directly reflected in household income. A higher income level induces the household to consume more of each sector's good. Even though the level of consumption on each type of good increases over time, their share in total expenditures remains the same during the transition period. According to Table 10, the share of each sector's production in total GDP is equal to the share of each type of good's consumption in total expenditures in the steady state. For instance, the share of non--tradable sector's production is 7.2 percent at the steady state which is nearly the same as the share of expenditure on non-tradable good consumption in total expenditure which is 7 percent. The same applies to the remaining sectors, as well. Thus, it is implied that production in the closed economy framework adjusts to consumption demand. The results show that the closed economy model provides a domestic demand-driven environment for production.

#### *4.2.3 A Brief Comparison*

Table 12 compares the GDP, expenditure and wage values of the partial capital mobility model and non-capital mobility models. Although in both models there is positive growth in income, expenditure and output value, all of these values are greater in the no capital mobility model. This stems mainly from the fact that part of income generated in the partial capital mobility economy is devoted to the repayment of debt. This conclusion is similar to that of Gourinchas and Jeanne (2002). They argue that since the domestic country has to pay for the initial capital flows with interest, consumption is smaller in the open economy framework compared to the financial autarky case.

Secondly, slower accumulation in physical capital in the partial capital mobility model (due to its relatively lower rate of return) leads to a slower increase in productivity of other factors of production, raw labor and human capital. Particularly, comparing the two models' results, we observe that wages rise at a much slower rate in the partial capital mobility economy. As a result of relatively lower wage increase, the improvement in total income is also more modest in the open economy framework.

Another impact of international capital flows can be observed by analyzing the different trends in physical and human capital stocks in non-capital mobility and partial capital mobility environments. The transitional behavior of $h/k$ ratio gives much information about

the different outcomes of the respective models. In the non- capital mobility economy, the rates of return to both types of capital stocks are equal; therefore, the capital stocks are considered to be the same throughout the analysis. Similar to the conclusion of Barro, et al. (1995) in the closed economy model, the ratio of $h/k$ in each sector is constant throughout the transition period until the steady state. Since both types of capital stocks face the same rate of return, the ratio of capital stocks is determined only by their relative elasticities which do not change over time. Hence, a constant ratio of $h/k$ in each sector is observed. However, in the partial capital mobility framework, the rates of return are no longer the same in the initial period so that the $h/k$ ratio changes during transition. In fact, it increases over time as can be observed from Table 8. Yet, the rates of return to physical capital and human capital are equalized at the steady state. Due to the rise in $h/k$ ratio diminishing returns set in much sooner than they would in the non- capital mobility economy. Therefore, we observe a slower accumulation in human capital in the partial capital mobility model.

Analyzing these two frameworks, it is observed that the presence of international capital flows in the economy reverses the sectoral allocation of production and resources as well. Compared to the non-capital mobility case, the sectoral allocation of production follows an opposite path in the open economy framework. When the economy does not allow for international capital flows, the factor re-allocation and competition takes place between the non-tradables and home services. On the contrary, when the economy allows international capital flows with a constraint, economic development stimulates the share of tradable-good sector's production and brings about a decline in the share of non-tradables and home services. Thus, this time the factor re-allocation takes place between the non-tradables and home-services. The presence of partial capital mobility shifts the production pattern in favor of labor intensive sectors, while when the economy is close to international capital flows production pattern changes in favor of relatively more human-capital intensive sectors.

Based on the above analyses on production and income it can be inferred that in order for the international capital flows to benefit economies, it should not only improve the efficiency of international capital reallocation, but it should also increase the productivities in each sector. Similarly, Gourinchas and Jeanne (2002, 2003) argue that international financial integration leads to gains in less developed countries only if capital flows raises the productivity in those countries. Our results concur that the inflowing international capital should bring forth human capital-augmenting technological progress to benefit the domestic production and factor allocation.

## 5. Conclusion

This study focused on the impact of international capital flows in a multisector economy based on a dynamic general equilibrium analysis. Using a three-sector Ramsey model, a comparative analysis is conducted between the cases of financial autarky and financial openness in order to detect the movements of factors of production across sectors.

The model's numerical results demonstrate striking differences between the open economy under partial capital mobility with a borrowing constraint and that of the closed economy under non-capital mobility. In the open economy framework, the comparison between the initial and the steady state values of the endogenous variables pose certain conclusions about the transitional behaviour of production, resource allocation, domestic consumption and capital accumulation.

In this model, the distinction between human capital and physical capital is ensured by the borrowing constraint. Economic growth in the economy brings about capital accumulation in both types of capital. However, contrary to the closed economy model, human capital accumulates more than physical capital as can be derived from the difference between the steady state values of $h/k$ ratios in both environments. While the transitional period in the

closed economy leaves the $h/k$ ratio constant (by equality of rates of return on both capital types), the ratio increases in the open economy framework.

Even though one type of capital accumulates more than the other, the total capital accumulation brings about economic growth and a corresponding change in production. Starting with the same initial shares of sectoral production in total GDP, the closed economy and open economy frameworks experience different transitional changes leading to distinct steady state outcomes. Thus, patterns in production, consumption and allocation of resources between sectors alter as international capital mobility is allowed in the economy. As contrasted to the closed economy case, the sectoral allocation of factors of production is reversed in the open economy case. In particular, when the economy allows international capital flows with a constraint, the evolution to the steady state results in a higher share of tradable-goods sector's production and brings about a decline in the share of non-tradable goods and home services sectors. The change in production also brings about a re-allocation of resources in favor of the tradable-goods sector and away from the non--tradable goods and home-services sectors. As capital accumulation takes place, labor and both types of capital stocks are channeled towards the tradable-goods sector which is the most labor intensive sector in the economy. When the economy is closed to international capital flows, long run equilibrium results in capital accumulation that raises the importance of the home-services and tradable goods sectors, but causes the importance of the non-tradable goods sector to diminish. The increase in the share of home-service production is higher than that of the tradable goods such that eliminating international capital flows leads production to shift in favor of more human-capital intensive goods. As a result, opening the capital account brings about a competition between tradable-goods and non-tradables sectors with respect to obtaining the resources that are to be reallocated. It means that the presence of international capital flows changes the production pattern in favor of labor-intensive goods and away from human-capital intensive goods.

Apart from the divergence in the reallocation of resources across sectors between the two environments, despite the fact that both economies experience growth in income, expenditure and output value, we observe that the growth in income, expenditure and output value is limited in partial capital mobility economy compared to the non-capital mobility economy. This result brings forth the proposal that capital mobility must be accompanied by some positive rate of technological progress to compensate for the slow down in rate of capital accumulation. That is, in addition to more efficient allocation of resources, the inflow of international capital should also bring about human-capital augmenting technology. In that way, financial integration will bring forth the promised benefits of international capital flows to the developing countries.

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**Table 1: The sectoral composition of GDP in Turkey (2002)**

| | Total (000 TL) | Shares (%) |
|---|---|---|
| Non-tradables | 64,775,095 | 22.5 |
| Tradables | 64,538,368 | 22.2 |
| Home-services | 161,460,304 | 55.3 |
| Total GDP | 290,773,767 | 100 |

Source: Input-Output Table, 2002 (TURKSTAT) and own calculations

**Table 2: Household Consumption Expenditures (2002)**

| | Total (000 TL) | Share (%) |
|---|---|---|
| Non-tradables | 15,614,574 | 7.1 |
| Tradables | 51,970,508 | 24 |
| Home-services | 149,829,353 | 69 |
| Total Expenditures | 217,414,435 | 100 |

Source: Input-Output Table, 2002 (TURKSTAT) and own calculations

**Table 3: Investment in Human and Physical Capital (2002)**

| | Total (000 TL) |
|---|---|
| *Human capital* | *11,630,950* |
| *Gross fixed physical capital formation* | *61,728,381* |
| Import of capital goods | 12,567,860 |
| Investment in domestic capital goods | 49,160,521 |
| *Total Investment and Saving* | *73,359,332* |

Source: Input-Output Table, 2002 (TURKSTAT) and own calculations

**Table 4: The Sectoral Allocation of Labor in Turkey (2002)**

| | Total (000) | Shares (%) |
|---|---|---|
| Non-tradables | 3,929.1 | 18.6 |
| Tradables | 5,722.9 | 26.7 |
| Home-services | 11,680.6 | 54.7 |
| Total Employment | 21,354 | 100 |

Source: Input-Output Table, 2002 (TURKSTAT), Labor Statistics, 2002 (TURKSTAT) and own calculations

**Table 5: Factor Elasticities in The Partial Capital Mobility Model**

| | Raw Labor (%) | Human Capital (%) | Physical Capital (%) |
|---|---|---|---|
| Non-tradable goods production | 26.2 | 52.5 | 21.2 |
| Tradable goods production | 38.3 | 40.4 | 21.2 |
| Home-services production | 31.4 | 47.4 | 21.2 |

Source: own calculations

**Table 6: Factor Elasticities in the No-Capital-Mobility Model**

| | Raw Labor (%) | Broad Capital (%) |
|---|---|---|
| Non-tradable goods production | 26.2 | 73.7 |
| Tradable goods production | 38.3 | 61.7 |
| Home-services production | 31.4 | 68.6 |

Source: own calculations

**Table 7: Common Parameters in Both Models**

| | Symbol | Value |
|---|---|---|
| *Consumption share in expenditure (%)* | | |
| Non-tradable good | $\lambda_1$ | 7 |
| Tradable good | $\lambda_2$ | 24 |
| Home-services | $\lambda_3$ | 69 |
| *Elasticity of intertemporal substitution* | $1/\theta$ | 1 |
| *Time preference rate* | $\rho$ | 0.042 |

## Table 8: Results from the Partial Capital Mobility Model (1)

| | Initial value | Steady state |
|---|---|---|
| *Production shares (%)* | | |
| Non-tradable goods sector | 22.5 | 5.7 |
| Tradable goods sector | 22.2 | 40 |
| Home-services sector | 55.3 | 54.3 |
| *Sectoral allocation of labor (%)* | | |
| Non-tradable goods sector | 18.6 | 4.4 |
| Tradable sector | 26.7 | 45.3 |
| Home-services sector | 54.7 | 50.3 |
| *Sectoral allocation of physical capital (%)* | | |
| Non-tradable goods sector | 22.2 | 5.7 |
| Tradable goods sector | 22.2 | 40 |
| Home-services sector | 55.5 | 54.3 |
| *Sectoral allocation of human capital (%)* | | |
| Non-tradable goods sector | 24.9 | 6.6 |
| Tradable goods sector | 19.1 | 36 |
| Home-services sector | 56 | 57.3 |
| *Consumption shares in expenditure (%)* | | |
| Non-tradable goods | 7 | 7 |
| Tradable goods | 24 | 24 |
| Home-services | 69 | 69 |
| *H/K ratio* | | |
| Non-tradable goods sector | 1,64 | 2,47 |
| Tradable goods sector | 1,26 | 1,90 |
| Home-services sector | 1,48 | 2,23 |

## Table 9: Results from the Partial Capital Mobility Model (2)

| (billion TL) | Initial value | Steady state |
|---|---|---|
| GDP | 290,8 | 420,37 |
| Domestic savings ( $\dot{h},$ only) | 11,63 | 0,0 |
| Total savings ( $\dot{z}$ ) | 74,42 | 0,0 |
| Expenditures | 216,4 | 330,95 |
| Relative prices | | |
| Non-tradable good | 1 | 0,9 |
| Tradable good | 1 | 1 |
| Home-services | 1 | 0,94 |
| Wages | 92,39 | 142,37 |
| Rents to human capital | 136,61 | 188,59 |
| Net factor payments to foreigners ( $rd$ ) | 61,73 | 89,2 |

## Table 10: Results from the No Capital Mobility Model (1)

| | Initial value | Steady state |
|---|---|---|
| *Production shares (%)* | | |
| Non-tradable goods sector | 22.5 | 7.2 |
| Tradable goods sector | 22.2 | 24 |
| Home-services sector | 55.3 | 68.9 |
| *Sectoral allocation of labour (%)* | | |
| Non-tradable goods sector | 18.6 | 5.8 |
| Tradable sector | 26.7 | 28 |
| Home-services sector | 54.7 | 66.2 |
| *Sectoral allocation of broad capital (%)* | | |
| Non-tradable goods sector | 24.3 | 7.9 |
| Tradable goods sector | 20 | 21.9 |
| Home-services sector | 55.6 | 70.2 |
| *Consumption shares in expenditure (%)* | | |
| Non-tradable goods | 7 | 7 |
| Tradable goods | 24 | 24 |
| Home-services | 69 | 69 |

## Table 11: Results from the No Capital Mobility Model (2)

| (billion TL) | Initial value | Steady state |
|---|---|---|
| GDP | 290,8 | 546,4 |
| Total (Domestic) savings ( $\dot{z} = \dot{h} + \dot{k}$ ) | 74,42 | 0,0 |
| Expenditures | 216,4 | 546,4 |
| Relative prices | | |
| *Non-tradable good* | 1 | 0,88 |
| *Tradable good* | 1 | 1 |
| *Home-services* | 1 | 0,93 |
| Wages | 92,39 | 178,6 |
| Rents to broad capital | 198,39 | 367,8 |

## Table 12: Comparison of the Results

| (billion TL) | Initial value | Partial Capital Mobility | No Capital Mobility |
|---|---|---|---|
| GDP | 290,8 | 420,37 | 546,4 |
| Expenditures | 216,4 | 330,95 | 546,4 |
| Wages | 92,39 | 142,37 | 178,6 |