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# Endogenous current account balances in a world CGE model with international financial assets ☆

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ABSTRACT

This paper presents an applied computable general equilibrium world model with financial assets and endogenous current account, and capital and financial account balances. The capital and financial account equilibrium conditions, rather than exogenous rules, constrain the current account balance. International capital flows which balance the current account are constrained by supply-and-demand equilibrium conditions on the market for international debt securities, under portfolio managers' optimizing behavior. The asset–liability structure of the financial portfolio is endogenous, and it is possible for a country-agent to have negative net financial assets. In simulations, the interaction of portfolio choices with trade supply and demand behavior leads to endogenous sign reversals in some current account balances, and it results in a different allocation of investment among regions, compared to a model with exogenously determined current account balances. In the reference scenario, this allocation generates growth that is about the same globally, but differently distributed between regions.



## 1. Introduction

By the end of 2009, the U.S. net international investment position (IIP) was at −$2737.8 billion dollars.[3] At the same time, Japan had a positive IIP of $2889 billion,[4] and China a positive IIP of $1791 billion.[5] These impressive figures are the cumulative consequences of recurrent capital and financial account imbalances, but most world trade CGE models ignore the capital and financial counterpart of current account deficits and surpluses.

In this paper, we discuss the extension of the Walrasian equilibrium principle to the current account balance, and to the capital and financial account balance in the PEP-w-t-fin model (Lemelin et al., 2010, 2012), a worldwide recursive dynamic CGE model with international financial assets. Our model endogenizes current account balances by making explicit the international capital flows which offset the current account. Capital flows are constrained by supply-and-demand equilibrium conditions on the market for international debt securities, as determined by portfolio managers' optimizing behavior. Each country is a single agent, owning a portfolio of assets which constitutes its net wealth. Wealth consists of financial wealth and physical assets (ownership titles to productive capital or claims on the flow of income generated by it). Financial wealth is made up of international assets and liabilities (debt). The asset–liability structure of the financial portfolio is endogenous, and it is possible for a country-agent to have negative net financial assets. Borrowing is limited, however, by the willingness of other country-agents to lend, following their own portfolio choices, and by the competition from other borrowing countries.

The cumulative consequences of capital flows on the international investment positions (IIPs) of countries define the constraints under which portfolio choices are made. Interaction between the financial and the real economy may lead, for example, to endogenous sign reversals

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[3] U.S. Bureau of Economic Analysis: http://www.bea.gov/newsreleases/international/intinv/intinvnewsrelease.htm.

[4] ¥ 266.2 trillion at 92.13 ¥/$. Source: Bank of Japan, *Japan's International Investment Position at Year-End 2009*, BOJ Reports & Research Papers, Bank of Japan International Department, September 2010 (http://www.boj.or.jp/en/research/brp/ron_2010/data/ron1009a.pdf).

[5] Government of China, State Administration of Foreign Exchange (SAFE): http://www.safe.gov.cn/.

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in current account balances, a feature which is absent in most CGE models. Nonetheless, experiments with the model have shown that the real economy remains the principal driving force determining the simulated evolution of the world economy.

## 2. Financial assets and capital mobility

The main purpose of this paper is to show how a model with financial assets and endogenous current, and capital and financial account balances can contribute to our understanding of the possible evolution of the world economy. Our approach is related to the literature on capital mobility. In a careful and insightful discussion of terminology, Islam (1999) makes the distinction between "mobility of *current* capital",[6] "mobility of savings",[7] and "mobility of capital", the latter encompassing the first two. In our view, however, it is desirable to deepen the distinctions put forth by Islam, and distinguish between the mobility of physical capital, and the mobility of financial capital, where the latter implies the mobility of savings (and therefore of investment), but broadens the concept to the mobility of stocks of financial assets, including portfolio equity and foreign direct investment. The mobility of financial capital does not imply the mobility of installed physical capital, since ownership can change hands while physical capital remains immobile. In the PEP-w-t-fin model, capital mobility takes the form of *financial* capital mobility.

The same type of capital mobility is found in the intertemporal dynamic CGE model of Goulder and Eichengreen (1989).[8] It is also found in the version of the DART recursive dynamic model applied by Hübler (2011), whose specification of foreign direct investment follows Springer (2003). In that version of DART, financial capital is allocated according to a portfolio model adapted from Goulder and Eichengreen (1989) to the recursive dynamic framework. Portfolio composition enters the household utility function. As return rates diverge from their initial values, the household can increase income (and therefore consumption), by allocating wealth differently from the initial portfolio composition. But changes in allocation are tempered because any departure from the preferred initial portfolio composition entails a utility cost, due to imperfect substitutability between domestic and foreign capital and a home bias in the household's portfolio.

The G-Cubed model also has internationally mobile financial assets. McKibbin and Stoeckel (2009) present the G-Cubed model as a dynamic stochastic general equilibrium model (DSGE), but the *stochastic* element is absent (at least from the publicly available documentation to which the authors refer: McKibbin and Wilcoxen, 1999). So it is more accurate to say that it is a dynamic intertemporal general equilibrium model. In G-Cubed, installed physical capital is industry- and region-specific, but financial capital is perfectly mobile between industries and regions. Its allocation is driven by forward-looking investors who respond to arbitrage opportunities. Intertemporal optimization by households and firms determines saving and investment (the creation of new physical capital). Households maximize an intertemporal utility function subject to a lifetime budget constraint, and so determine the level of saving, while firms choose investment to maximize the stock market value of their equity. Current account balances are endogenous, financed by flows of assets between countries. An intertemporal budget constraint is imposed on each region: all trade deficits must eventually be repaid by future trade surpluses. With financial capital markets perfectly integrated worldwide, expected returns on assets are equalized in each period according to a set of interest arbitrage relations based on the risk-adjusted interest rate parity assumption. Household wealth portfolios include four types of assets: money, real government bonds, net claims against foreign residents, and capital. Money demand is transaction-based, proportional to the nominal value of output, where the proportion is a constant-elasticity function of the interest rate. All other assets are perfect substitutes, so that risk-adjusted return rates are equalized, taking into account the costs of adjusting capital stocks. All risk premiums are exogenous. In addition, G-Cubed includes "New Keynesian" features, such as liquidity-constrained agents and slow nominal wage adjustment. The model is designed to converge in the long run to a Ramsey neoclassical growth path.

Another model that includes the mobility of financial capital is GTAP-Dyn, the dynamic version of the GTAP model (Ianchovichina and McDougall, 2001; Ianchovichina et al., 2000). GTAP-Dyn differs from most recursive dynamic models in that it is formulated in continuous time, which is made possible by the differential equations approach of GEMPACK (General Equilibrium Modelling Package).[9] GTAP-Dyn distinguishes between asset location and ownership and, hence, between physical capital and claims on physical capital; the latter are represented in the model by a single asset, equity.[10] In GTAP-Dyn, capital is perfectly mobile between industries within regions, but installed capital is not mobile between regions. Savings, however, are internationally mobile, through the mobility of equity assets (financial, as opposed to physical capital). Current account balances are endogenous, offset by capital account balances reflecting international flows of assets. Household wealth consists of equity. A fraction of wealth is equity in domestic capital; the rest is in the form of shares in a global trust fund which owns the fraction of capital in each region which is under foreign ownership. GTAP-Dyn does not make use of portfolio allocation theory. Portfolio shares and ownership shares are determined by a minimum cross-entropy rule relative to initial distributions, subject to the international distribution of the stock of capital, given investment, valued at replacement cost. The distribution of capital between regions changes in time through the distribution of investment, according to the accumulation rule. Investment is entirely equity-financed, and its regional distribution is determined according to the investment theory laid out in Ianchovichina and McDougall (2001). Investment is forward looking, but it is not the result of micro-founded intertemporal optimization; rather, it is driven by a mechanism that operationalizes the economic postulate that return rates will converge in the long run if capital is mobile, albeit imperfectly.[11] The model is designed to converge towards a balanced growth

[6] "*Mobility of current capital* denotes mobility of capital that is already in place and is participating or can participate in production during the current period." (Islam, 1999, p. 3).

[7] "*Mobility of savings* denotes mobility of resources that become capital in the next period through purchase and installation of investment goods during this period." (Islam, 1999, p. 3).

[8] "Neither labor nor physical (as distinct from financial) capital is mobile internationally" (p. 8).

[9] https://www.gtap.agecon.purdue.edu/models/current.asp. The Centre of Policy Studies (CoPS) at Monash University in Melbourne, Australia, develops and supports GEMPACK.

[10] The version of MIRAGE developed by Lemelin (2009) also distinguishes between capital location and ownership, but the menu of assets includes international debt securities and the portfolio allocation mechanism is based on a micro-theoretic optimization model.

[11] The model postulates that regional rates of return gradually converge to their target values, which are equal across regions except for risk premia and differences in depreciation rates. A convergence rule determines intermediate, or short-term, target rates (called expected rates in the model). The role of the intermediate target is to determine investment, i.e. the growth rate of capital, in such a way that actual rates will evolve towards the intermediate targets and, eventually, towards the long-run target rates. The rate of capital growth required to achieve convergence is computed from an aggregate CES region-wide production function. Since the aggregate production function is a simplified representation of the regional production system, the required rate of capital growth cannot be computed exactly, and the actual rate of return does not instantly converge to the intermediate target. Indeed, actual regional return rates are derived from the rental rate of capital and the price of the capital good, both determined by supply and demand equilibrium. Consequently, supply and demand equilibrium will not, in general, make the actual return rate equal to the intermediate target (expected rate). The discrepancy between the intermediate target (expected) rate of return and the actual rate is used to revise the parameters of the aggregate model of the regional economy. All adjustments are partial adjustments rather than instantaneous adjustments. The adjustment parameters are calibrated to achieve a desired speed of convergence of regional return rates to the long-run equilibrium target rates (see Golub and McDougall, 2012, p. 12–13). Overall, the GTAP-Dyn investment theory, more than an investment theory, is a model where investment is imperfectly mobile globally, and is allocated among regions in such a way that regional rates of return converge gradually, but without sudden mutations in the pattern of regional investment.