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Capital accumulation and international trade☆

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ABSTRACT

Capital accumulation is introduced into a version of Eaton–Kortum model of international trade, imposing period by period balanced trade. The effects of tariff changes on world steady states and transition dynamics are studied. A calibrated version of the model is used to assess the short- and long-run gains from a world-wide elimination of trade tariffs. The determinants and importance of convergence in world-wide capital as well as convergence on the relative capitals and incomes are analyzed. Positive and normative comparisons with an analogous static model are conducted, as well as comparisons steady state welfare comparisons vs full dynamic gains.

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1. Introduction

Capital accumulation is introduced into the Eaton and Kortum (2002) model of trade, modified as in Alvarez and Lucas (2007). The Eaton–Kortum model has a single primary input: non-tradeable labor. In Alvarez and Lucas (2007) labor was interpreted as "equipped labor" and identified the income of this factor with value added. This broadened view enabled to calibrate the model realistically to U.S. national income and product data, but did not give a framework for analyzing any genuine dynamics. In this paper I add physical capital as a second primary input, also assumed non-tradable, and add investment goods as a second final good, along with consumption. International trade occurs in continuum of intermediate goods, modeled as in Alvarez and Lucas (2007). Intertemporal preferences and a law of motion for capital are taken from standard growth theory. It is assumed that countries must balance trade continuously, i.e. no borrowing or lending is allowed. The combined model describes the equilibrium of a world of n economies evolving over time as a system of autonomous differential equations.

Section 2 considers capital accumulation into a single, autarchic economy, with the industrial structure and commodity space of the Eaton–Kortum and Alvarez–Lucas setup, obtaining the one-sector model of economic growth that is the basis for the analysis to follow. Section 3 sets up the notation for a world economy of n such economies and discuss the general mathematical structure of the theory. Sections 5–7 study income "convergence" in a world of different economies, under the

☆ The title of this paper and some of its material is taken from a 2009 draft circulated (but never published) with Robert E. Lucas, Jr. Bob has contributed fundamentally to some of the main ideas and results of this 2009 paper but he felt that his lack of involvement in the current, quite different paper should be reflected in his withdrawal from the title. I thank Bob for his ideas, encouragement and generosity. Of course, all the errors and shortcomings are, quite literally, only mine. I thank Lorenzo Caliendo, Jaume Ventura, and Jonathan Eaton for excellent comments. Finally, I thank Francisca Sara-Zaror for her research assistance.

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assumption of costless trade. In this context, the existence and uniqueness of equilibrium steady states can be established quite easily and generally, as done in Section 4. Steady states have a very similar nature as equilibrium for a static economy without capital. Section 5 examines the dynamics of a small, open economy when the rest of the world is at stead state. A small open economy has dynamics similar, but not identical, to the ones from the one sector closed economy growth model. The speed of convergence of the one country growth model of Section 2, as it is well known, is controlled by a race between intertemporal willingness to substitute consumption and the elasticity of the marginal productivity of capital with respect to an additional unit of capital. Interestingly, the elasticity of the marginal productivity of capital is higher for the small *open* economy, since an additional unit of capital expand production, as in the closed economy but this expansion has the additional effect of depressing the prices of the products the small open economy sells. As a consequence, the small open economy has a higher speed of convergence than the one sector closed economy growth model. Section 6 examines the stability of a n-country steady state in a symmetric world. The speed and nature of adjustment to steady state in a world of n countries, whose state is the vector on the n capital stocks for each country, is dictated by two considerations, i.e. it is dictated by two distinct eigenvalues. One eigenvalue is the same as in the standard one country closed economy growth model –which is natural since then entire world is a closed economy– and controls the convergence of the average world-wide capital to its steady state. The other eigenvalue is the same as in the small open economy –which is natural since in a world with countries with different capital levels there are further incentive for international trade– and controls the convergence of each country level of capital relative to the average world-wide capital.

The models analyzed in Sections 2 to 6 are selected to reveal the structure of the equilibrium dynamics in the clearest possible way, free of unnecessary complications. For calibration and policy simulations trade costs (i.e. tariffs) and differential content of tradeable inputs in the production of investment goods relative to consumption goods are incorporated. The first element is required to study a trade liberalization. The second element, a feature of actual economies, is important to obtain a realistic estimate of the long-run response to reductions in trade costs, since this feature implies a permanent reduction in the relative price of investment to consumption goods. This version of the model, its calibration, as well as positive and normative exercises are in Section 7. In particular, I study the path of adjustment for the whole world after a trade liberalization –i.e. the dynamics for an entire world starting at a steady state calibrated to the observed heterogeneous tariffs and GDP size, and whose tariffs are permanently reduced to zero for all countries. Following the theoretical decomposition of the dynamics, I study this liberalization first in a model with all countries are assumed to be identical, and later in one with a realistic level of heterogeneity in tariffs and country size. The welfare implications in the dynamic model that properly takes the transition path into account is compared with an analogous static model without capital accumulation, and also compared with the steady state of the dynamic model. For the average country, the steady state comparisons vastly exaggerate the welfare gains relative to the welfare gains properly computed taking the transition into account. Instead, the static model underestimates the welfare gains relative to the dynamic model, but they are much closer. This is true even though the prediction for the volume of trade (i.e. trade to GDP) is almost identical between the steady state comparison and the static model without capital accumulation. Furthermore, the pattern of welfare gains, as a function of the pre-trade liberalization tariff of each country, are similar for the static and dynamic model that takes the transition into account. Yet these patterns and magnitudes are different if one compares the welfare gains of each country as a function of the pre-trade liberalization tariff across steady states. As a summary, the dynamic model implies larger property measured welfare gains than the static one, and, as in many related setups, the steady state welfare comparisons prove to be misleading.

The analytical results that extend the treatment of Sections 2–6 to the more realistic setup can be found in Appendix A to Appendix D. Among these results are the effects of the average size of each country and of the trade costs on the speed of convergence on the relative capitals –see Proposition 6, the effect of the higher tradable component on the production of capital goods relative to consumption goods on the transitions and steady states –see Proposition 4 and Proposition 7, and the behavior the relative price of consumption to tradeables goods and the relative price of investment to consumption goods during the transition –see again Proposition 7. Conclusions are offered in Section 8.

1.1. Related research

This paper is a contribution to the research on integrated models of trade and growth dating back at least to Stiglitz (1970) and including Chen (1992), Ventura (1997), Atkeson and Kehoe (2000), Acemoglu and Ventura (2002), Bajona and Kehoe (2010), Caliendo (2011) and Eaton et al. (2016). With the exceptions of Acemoglu and Ventura (2002) and Eaton et al. (2016), discussed below, all of these earlier papers combine versions of the two-factor Heckscher–Ohlin type model with endogenous capital accumulation. With a common technology and preferences, capital-labor ratios in different countries will converge to common levels under autarky. The goal of these analyses is to characterize the way that trade—assumed to be costless and continuously balanced— affects the steady state and the transition paths of the world economy. As it is well known, factor price equalization can occur in these models without equalization in capital-labor ratios, and the nature of the dynamics depends critically on whether or not the world economy is in the "cone of diversification" (the region of factor price equalization). Ventura (1997) is based on assumptions that ensure that the cone of diversification is the entire non-negative orthant. Chen (1992), Atkeson and Kehoe (2000), Bajona and Kehoe (2010) and Caliendo (2011) adopt weaker assumptions so they can examine behavior in and outside of the cone and the transitions between. These studies differ in many details with different results, but in instances where long-run behavior can be characterized, the finding is that factor prices are ultimately equalized but capital-labor ratios need not be. At a general level, these models links capital

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