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Learning by exporting and structural change: A Ramsey growth model of Thailand☆

Xinshen Diao[a], Jørn Rattsø[b,*], Hildegunn E. Stokke[b]

[a] *International Food Policy Research Institute, Washington, DC, United States*
[b] *Department of Economics, Norwegian University of Science and Technology, Dragvoll Campus, N-7491 Trondheim, Norway*

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Abstract

Modern growth analysis emphasizes technology adoption and human capital as sources of growth and identifies high growth as temporary episodes. The long high growth experience of Thailand is a different story since the growth is not directly associated with advanced technology or high skill intensity. Our understanding is that Thailand's growth has been based on learning by exporting and labor-intensive manufacturing with expanding domestic backward linkages. The analysis using a Ramsey model shows how prolonged growth in Thailand can be explained by this learning mechanism and structural shift from agriculture to exportables. The relationship between exports and productivity is studied in a counterfactual experiment where protection serves as a barrier to exports learning and thereby reduces growth. Openness and structural change come out as the key ingredients of the growth strategy.

JEL classification: O4; O5

Keywords: Intertemporal growth modeling; Endogenous productivity growth; Learning by exporting; Trade and growth; Thailand

1. Introduction

Understanding the high growth experience of Thailand and the rest of East Asia has generated world-wide discussion on growth strategies and policy lessons. Our contribution is to clarify the

☆ A long appendix with full representation of the model is available from the authors upon request.

* Corresponding author. Tel.: +47 73591934; fax: +47 73596954.
E-mail address: jorn.rattso@svt.ntnu.no (J. Rattsø).

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mechanisms of productivity dynamics involved in Thailand. The Thai growth strategy seems to depart from the standard growth models of the literature. In a recent theoretical investigation of the way out of backwardness, Acemoglu, Aghion, and Zilibotti (2005) separate between investment-based and innovation-based strategies. They see economic growth as a movement from investment-oriented early stages to innovation-based growth later on. In the investment phase, technology adoption is encouraged by old and established firms and government involvement. Later the innovation phase needs new institutions, notably younger and smaller firms, selection of risk-taking entrepreneurs, and the discipline of the market.

The economic growth in Thailand certainly has been driven by investment and productivity growth, but most observers will agree that the country is not well described by the investment-based or innovation-based strategies. The industrial development is better characterized as simple labor-intensive manufacturing production than this focus on advanced technology. The labor-intensive exports growth has not been created in old established firms under government guidance, but rather by a large number of small scale firms with fairly simple technology. The gradual development of backward linkages to domestic industries has allowed use of more advanced technology. The productivity improvements associated with international spillovers are more the result of a broad learning process than direct application of high-tech production. The dynamics of this growth process is investigated in an intertemporal general equilibrium model emphasizing the productivity growth mechanism.

The broad background is the comprehensive literature on the East Asia growth experience (recent overviews are given by Weiss, 2005; Westphal, 2002). Needless to say, this literature includes intensive controversies concerning productivity growth versus investment, the importance of government policy, and the role of export orientation. Most analysts seem to agree that Thailand and other 'late-comers' (Malaysia, Indonesia) differ from the early 'Tigers' (South Korea, Taiwan, Singapore, Hong Kong). They share the high level of investment and the high exports growth, but government activism was less pronounced and the industrialization was less concentrated in Thailand and the others. Booth (1999) and Reinhardt (2000) address the different country experiences, while the recent Thai history is discussed by Jansen (2001) and Kochhar et al. (1996). We present a possible mechanism explaining the prolonged high growth. In our framework, both productivity growth and investment are endogenous, and their importance varies over time. Government is assumed first and for all to set the conditions for growth, with macroeconomic stability, good infrastructure, flexible domestic markets, and openness to foreign trade and investment.

Productivity growth is assumed to result from learning from the international market, not own investments in innovations and human capital, as explained in the next section. The learning is primarily associated with exports, but is also related to imports of intermediates and capital goods as sources of international spillovers. Domestic sectors take advantage of linkages to the growing export sector. Endogenous productivity growth is driven by multi-sector productivity interactions and is determined together with capital accumulation and structural adjustment. A broad understanding of the learning process includes human and institutional capital accumulation, but these aspects are not made explicit in the analysis.

We suggest an intertemporal model combining endogenous productivity mechanisms of new growth theory with old growth theory emphasis on investment and structural change during transition. Analyses based on static neoclassical general equilibrium models tend to underestimate the contribution of trade liberalization to economic welfare and growth. While the econometric literature discusses the causality between exports and productivity, we analyze the endogenous dynamic interaction between exports and productivity. The analysis is based on a Ramsey model with four

production sectors: exportables, importables, agriculture and nontradables. The prolonged high growth in the model is the result of productivity learning and structural change, together with slow transition resulting from adjustment costs and Armington goods heterogeneity. The model is calibrated to reproduce Thailand's growth experience given the backwardness and catch up possibilities in the 1960s. A counterfactual analysis of protectionist trade policy shows how foreign spillover and structural change is important for the catch up, and protectionism reduces productivity spillover and thereby investment and growth.

Section 2 puts the analysis in the context of the recent literature on productivity growth. Section 3 outlines the assumed productivity dynamics and describes the intertemporal general equilibrium model. Calibration of the high growth path is presented in Section 4, and the sources of growth are decomposed. Section 5 offers counterfactual analysis of openness and structural change, while concluding remarks are offered in Section 6.

2. Learning by exporting and productivity catch up

Economy-wide modeling of productivity growth in developing countries often take as a starting point the technology gap to advanced economies. Productivity growth as catching up is called the Veblen–Gerschenkron effect. Early formalizations were offered by Nelson and Phelps (1966) and Findlay (1978). Modern restatement of this model is presented by Parente and Prescott (1994, 2005) introducing the concept barriers to technology adoption. Nelson and Phelps (1966) concentrate on human capital as barrier, while the barriers as understood by Parente and Prescott (1994) are investment regulations. We focus on the broader role of international barriers as suggested in the literature of productivity spillovers and formulated by Grossman and Helpman (1991).

Developing countries with high productivity growth typically do not achieve this in isolation. Advanced technology is primarily developed in the very rich nations and based on their R&D input and innovations. Openness to foreign markets influences productivity growth through several mechanisms beyond imports of advanced technology, such as the discipline of the world market, incentive effects of competition, transfer of knowledge, foreign direct investment, etc. The broader learning associated with openness influences all aspects of production capabilities. The importance of international spillovers for productivity growth has been investigated in a comprehensive empirical literature and with analyses both at the national, sectoral and firm level. Although the econometric evidence is controversial, most authors conclude that openness is to the advantage of productivity growth. Coe, Helpman, and Hoffmeister (1997) is an influential cross-country study. The conclusion is reinforced in a study of East Asian countries by Frankel, Romer, and Cyrus (2000) taking into account the endogeneity of foreign trade.

Productivity growth is a complicated process and modeling the productivity mechanism necessarily must be very stylized. We follow recent econometric evidence suggesting that the export sector has been a key channel of productivity growth. Rapid export growth certainly has been an important characteristic of Thailand's economic growth. An early demonstration of the intersectoral beneficial externalities of the export sector is shown by Feder (1982). His analysis assumes that social marginal productivities are higher in the export sector and that the export sector confers positive effects on the productivity of other sectors in the economy. More recent econometric evidence has looked into possible documentation of learning by exporting. The econometric challenge is to separate between the selection into exports and the productivity improvement of being an exporter. Studies comparing exporters and nonexporters tend to conclude that the selection effect dominates. Fernandes and Isgut (2005) concentrate on young plants to get around the problem that firms already established in exporting may have less scope for further learning. They

find strong positive productivity growth effect of exports participation, and the result is consistent with studies of young firms by Delgado, Farinas, and Ruano (2002) and Baldwin and Gu (2003). Westphal (2002) reports 'ample case study evidence of links between export activity and technological change cum development' in East Asia.

Available country studies of Thai productivity growth, notably Rattsø and Stokke (2003), Tinakorn and Sussangkarn (1998), and Urata and Yokota (1994), confirm the role of foreign spillovers for TFP growth. The key role of the export sector is supported by recent micro evidence for Thailand supplied by Hallward-Driemeier, Iarossi, and Sokoloff (2002). They show how firms interacting with the world market through exports have higher productivity. Hallward-Driemeier et al. identify firms that began as exporters and conclude that they have higher productivity years later compared to firms oriented towards the domestic market.

3. Productivity dynamics and model setup

The productivity dynamics formulation combines foreign and domestic spillovers in a disaggregated technology gap model with the export sector as leading in the learning process. Imports are distinguished by different uses, and the main arguments of the adoption functions are the imports of intermediates and capital goods. Interaction with the TFP-leading export sector at the intermediate market contributes to productivity growth in agriculture and importables through backward linkages. We apply the modified Nelson–Phelps technology gap specification suggested and empirically tested by Benhabib and Spiegel (2005). The productivity dynamics is consistent with the catching up hypothesis, where the growth rate increases with the distance to the technological frontier. But compared to the original formulation the relationship between growth and technology gap is linear, and not exponential. This limits the advantage of backwardness and gives possible divergence in cases of high barriers to technology adoption. Rattsø and Stokke (2005) apply a related productivity specification in a Ramsey model for South Africa, but they focus on the endogenous combination of adoption and innovation more relevant for South Africa.

The export sector has a separate productivity dynamics in (1), with spillovers related to the intensive use of foreign intermediates and capital goods. Agriculture and importables also benefit from imported capital and intermediate goods, although less important, and from intermediate deliveries to the export sector, given in Eq. (2). The rate of growth of labor augmenting technical progress is specified as follows (time subscript is omitted):

$$\frac{\dot{A}_{\mathrm{ex}}}{A_{\mathrm{ex}}} = \lambda_{1,\mathrm{ex}} \left(\frac{N_{\mathrm{M,ex}}}{\mathrm{GDP}} \right)^{\gamma_{1,\mathrm{ex}}} \left(\frac{K_{\mathrm{M,ex}}}{\mathrm{GDP}} \right)^{\gamma_{2,\mathrm{ex}}} \left(1 - \frac{A_{\mathrm{ex}}}{T_{\mathrm{ex}}} \right) \tag{1}$$

$$\frac{\dot{A}_j}{A_j} = \lambda_{1,j} \left(\frac{N_{\mathrm{M},j}}{\mathrm{GDP}} \right)^{\gamma_{1,j}} \left(\frac{K_{\mathrm{M},j}}{\mathrm{GDP}} \right)^{\gamma_{2,j}} \left(1 - \frac{A_j}{T_j} \right) + \lambda_{2,j} \left(\frac{Ne_j}{\mathrm{GDP}} \right)^{\gamma_{3,j}}, \quad \text{for } j = \mathrm{ag},\ \mathrm{im}. \tag{2}$$

where $i = \mathrm{ag}, \mathrm{ex}, \mathrm{im}$ represents agriculture, exportables, and importables, respectively. A_i and T_i are the domestic and frontier level of productivity in sector i, respectively, and $(1 - A_i/T_i)$ is the productivity gap. $N_{\mathrm{M},i}$ represents total imported intermediate goods employed by sector i, $K_{\mathrm{M},i}$ is imported capital employed in sector i, and Ne_j is intermediate deliveries from sector j to the export sector. GDP is gross domestic product, while λ_1, λ_2, γ_1, γ_2 and γ_3 are constant parameters. Productivity growth in nontradables is assumed to grow exogenously at the long-run rate.

Under symmetric growth, the long-run productivity growth is given by the exogenous technology frontier growth rate g, and the productivity gap is constant. The degree of catch up depends on the extent of international and domestic spillovers in the economy. The long-run equilibrium consequently implies a proportional relationship between A and T in the export sector:

$$A_{\text{ex}} = \frac{\lambda_{1,\text{ex}}(N_{\text{M,ex}}/\text{GDP})^{\gamma_{1,\text{ex}}}(K_{\text{M,ex}}/\text{GDP})^{\gamma_{2,\text{ex}}} - g}{\lambda_{1,\text{ex}}(N_{\text{M,ex}}/\text{GDP})^{\gamma_{1,\text{ex}}}(K_{\text{M,ex}}/\text{GDP})^{\gamma_{2,\text{ex}}}} \cdot T_{\text{ex}} \tag{3}$$

and in the other sectors of the economy (j = ag, im):

$$A_j = \frac{\lambda_{1,j}(N_{\text{M},j}/\text{GDP})^{\gamma_{1,j}}(K_{\text{M},j}/\text{GDP})^{\gamma_{2,j}} + \lambda_{2,j}(Ne_j/\text{GDP})^{\gamma_{3,j}} - g}{\lambda_{1,j}(N_{\text{M},j}/\text{GDP})^{\gamma_{1,j}}(K_{\text{M},j}/\text{GDP})^{\gamma_{2,j}}} \cdot T_j \tag{4}$$

The steady state values of N_{M}/GDP, K_{M}/GDP and Ne/GDP are constant, and the relative productivities, A_i/T_i, are determined by their values, the frontier growth rate, and the parameters. Changes in the sources of international or domestic spillovers generate transitional growth to a new productivity gap. The dynamics is consistent with the common understanding that differences in income levels are permanent, while differences in growth rates are transitory (Acemoglu & Ventura, 2002).

Besides the productivity dynamics, the model is similar to Diao, Rattsø, and Stokke (2005), which emphasizes the endogenous interaction of productivity and capital accumulation. The extension captures the key role of the export sector for learning and the structural aspects of the Thai growth process. The model separates between domestic and foreign capital to capture the important role of foreign capital goods, both in overall investment growth and as source of international spillovers. Stokke (2004) investigates development traps in a similar framework. Detailed documentation of the model and the calibration is given in a separate appendix available from the authors.

The open economy Ramsey model is standard. The representative household allocates income to consumption and savings to maximize its intertemporal utility. All government revenue is consolidated to the household. The household also receives income from labor, capital and land, and pays interests on foreign debt. The isoelastic intertemporal utility function is maximized subject to a budget constraint, which says that discounted value of total consumption cannot exceed discounted value of total income over time. With the usual restrictions, we have the well-known Euler equation for optimal allocation of consumption:

$$\left(\frac{Q_{t+1}}{Q_t}\right)^{\sigma} \frac{PQ_{t+1}}{PQ_t} = \frac{1+r}{1+\rho} \tag{5}$$

where r is the exogenous world market interest rate, ρ the positive rate of time preference, σ the intertemporal elasticity of substitution, Q_t aggregate consumption in period t, and PQ_t is the aggregate consumption price. The growth in consumption depends on the interest rate, the time preference rate, the elasticity of substitution, and the price path. Higher interest rate or lower time preference rate motivate more savings and thereby higher consumption spending in the future.

On the production side, there is imperfect substitution between domestic and imported consumption and intermediate goods (through the Armington functions). As exports are possible in all the four sectors, CET functions are used to capture the imperfect substitution between goods produced for the domestic markets versus for exports. Labor and capital are mobile across sectors, while a fixed supply of land is only employed in agriculture. Given land supply being constant over time, land augmenting technical change in agriculture is assumed in order to have balanced

growth path in the long run. While the equilibrium rate of labor augmenting technical progress is the same across the four sectors, the sectoral TFP growth rates are different even in the long run. This is because of land employed only in agriculture and because of the differences in labor intensities.

The aggregate capital stock is managed by an independent investor who chooses an investment path to maximize the present value of future profits over an infinite horizon, subject to the capital accumulation constraints. Differentiating the intertemporal profit function with respect to domestic and foreign capital gives us the well-known no-arbitrage conditions:

$$r \cdot q_{k,t-1} = Rk_{k,t} + a_k \cdot \mathrm{PD}_{nt,t} \cdot \left(\frac{I_{k,t}}{K_{k,t}}\right)^2 - \delta_k \cdot q_{k,t} + \dot{q}_{k,t} \tag{6}$$

where $k = \mathrm{D}, \mathrm{M}$ represents domestic and foreign, respectively. The condition in (6) states that the marginal return to capital has to equal the interest payments on a perfectly substitutable asset of size $q_{k,t-1}$. The first term on right hand side, $Rk_{k,t}$, is the capital rental rate that can be different for domestic and foreign capital, while the second term is the derivative of capital in the adjustment cost function. a_k is a (constant) efficiency coefficient, which is different for domestic and foreign capital in the adjustment functions, PD_{nt} the price of the nontradable good, while I_k is investment in real terms. The marginal return to capital also has to be adjusted by the depreciation rate, δ_k, and capital gain or loss, $\dot{q}_k$.

Investments can be financed through foreign borrowing, and the decisions about savings and investment can, therefore, be separated, although with a long-run restriction on foreign debt. Increase in foreign capital inflows (i.e., trade deficits) in the current period, together with interest payments on existing debt, augments foreign debt in the next period.

In the long-run equilibrium growth of capital stocks and foreign debt approach a constant rate given by $g + n$, where g is the long-run growth rate of labor augmenting technical progress and n is the labor supply growth rate.

4. Calibration of Thailand's growth path

The model is calibrated to reproduce Thailand's high growth experience 1960–1998. The endogenous spillover and multi-sector productivity interaction contribute to prolonged transition growth above world normals. Increasing productivity growth counterbalances the decline in the growth rate with decreasing returns to capital accumulation. The average labor force growth rate during 1961–1998 equals 2.6% (World Bank, 2001), and we have assumed a long-run labor growth rate of 3%. Growth accounting analyses of Thailand (Collins & Bosworth, 1996; Tinakorn & Sussangkarn, 1998; Young, 1994) tend to identify TFP growth in the order of 2% during the high growth period. With a labor share of 0.4 the corresponding labor augmenting technical progress rate equals 5%. Since the productivity growth during the past decades has been exceptionally high, we assume a long-run technical progress rate of 3.5%. This gives a long-run equilibrium growth rate of 6.5% (3.5% technological progress rate and 3% labor growth).

The calibration is based on a Social Accounting Matrix developed by the National Economic and Social Development Board (NESDB) in Thailand, and the original SAM is aggregated into four sectors. Exportables, importables and nontradables are defined based on export and import intensity in production and demand. Agriculture is defined by production characteristics. The export sector has an export–output ratio of 43% and accounts for two-thirds of total exports in the economy. Total sales of the exportable good consist of about 25% imported goods. Foreign

goods account for 40% of sales of the importable good. The sectoral aggregation implies that all the four sectors included in the model have tradable elements, but the role of imports and exports differ significantly across sectors. The sectoral interactions are important to our understanding of the dynamic linkages between trade and growth through export learning and import technology spillovers.

Starting from the base year 1998, we calibrate backward a growth path reproducing the observed real GDP growth for the previous 4 decades. To reproduce the actual GDP of 1960, the initial level of capital stocks is reduced to about 4% of the base year level. The labor supply is reduced according to the constant annual growth rate (3%), and foreign debt is adjusted to reproduce the initial year. The transition is accompanied by gradual reduction of import tariffs based on historical data. Sectoral tariff rates (relative to import) fall gradually from 30% in 1960 to about 5% in 1998. Other policy reforms implemented in the later period contributed to the gradual opening of the economy and increased trade and foreign investment, but they are not explicitly taken into account. The tariff reductions represent the broader opening of the economy. By ignoring the Asian crisis, the transitional growth path between 1960 and 1998 is converging towards a long-run equilibrium with overall growth of 6.5%. In the long-run equilibrium and along a balanced growth path the structure of the economy is stable and the savings–investment rate is constant.

The calibrated transitional growth varies over time and is generally declining. On average during 1960–1998 the annual growth is 7.8%, which is equal to the observed average growth rate in the data (from 1960 till the crisis). Actual and calibrated real GDP growth paths are shown in Fig. 1. The model captures the trend growth and does not represent the cyclical factors affecting the actual growth. Our understanding is that Thailand in the 1960s experienced new profit opportunities after reforms encouraging exports and investments. In the model this is observed as high marginal return to investment in the beginning of the growth period studied, with consequent high investment growth and capital accumulation. While investment dominates the early growth period, decreasing returns to investment over time reduces the speed of capital accumulation. However, foreign capital investment is held up due to gradually lowering of import tariffs during this period, which provides less expensive capital goods imported.

The productivity parameters are calibrated to reproduce the observed growth path. The first element is the productivity gap. Hall and Jones (1999) estimate the productivity level in Thailand

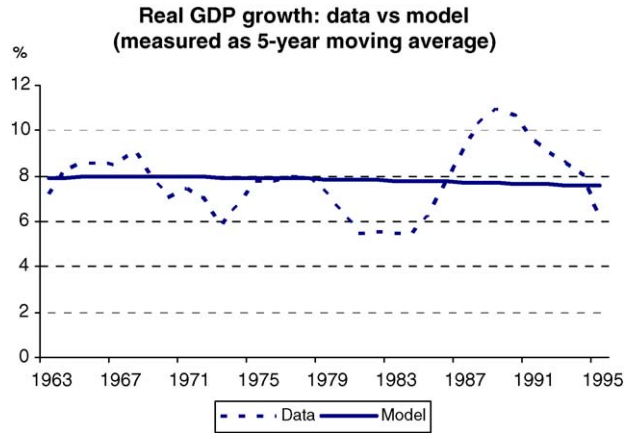

Fig. 1. Real GDP growth rate: calibrated path of model vs. actual growth (measured as 5-year moving average).

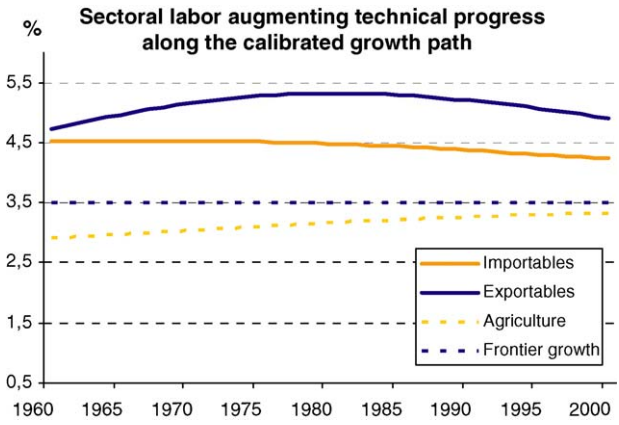

Fig. 2. Sectoral labor augmenting technical progress along the calibrated growth path.

to about 50% of the level in the US in 1988, corresponding to a productivity gap of 0.5. Data from Penn World Table (Version 6.1) indicates significant catching up in terms of PPP-adjusted real GDP per capita relative to the US, increasing from 0.24 in 1960 via 0.45 in 1988 to 0.68 in 1998. According to stylized facts, we assume that productivity represents the major share of the income catch up, and the relative productivity in exportables is calibrated to increase from 0.25 to 0.45 during 1960–1998 (illustrated in Fig. 4 in Section 5). The second element consists of the share parameters in the productivity equations. Broadly foreign spillovers contribute to 70% of the productivity growth, while the domestic spillovers with backward linkages represent the residual 30%. In the foreign spillovers, foreign capital represents two-thirds, while foreign intermediate contribute to the residual one-third.

The export sector is productivity-leading and with intensive use of foreign capital and intermediates, while agriculture and importables benefit from both foreign spillover and intermediate deliveries to the export sector. The sectoral paths of labor augmenting technical progress are shown in Fig. 2. The TFP growth paths follow similar patterns, but at a lower level. They result from both the productivity gap dynamics and the endogenous determination of foreign inputs and domestic linkages. The distance to the frontier represents the learning potential and the growth rate decreases as the economy catches up. High accumulation of foreign capital raises sectoral TFPs, especially in exportables, which employs imported capital more intensively. A higher productivity level allows the export sector to expand, which implies more imported intermediates and capital goods. The imports of foreign capital goods, together with gradual reduction of tariffs stimulating intermediate imports, explain the initial increase in productivity growth. The magnitude of the spillover effect declines over time and gives a concave productivity path in exportables. Productivity growth increases in the early period, but at a declining rate and eventually returns to the long-run growth rate of 3.5%. This follows from decreasing returns to international spillovers and gradual saturation of adoption opportunities. With a labor share of 0.26 (consistent with 1998 data for exportables) the average TFP growth rate during 1960–1998 equals 1.3%.

Productivity growth in the other domestic sectors (except nontradables) is driven by both domestic (through interaction at the intermediate market) and foreign (through imports of intermediates and capital) spillovers. Along the calibrated path intermediate deliveries to exportables (as share of GDP) increase significantly in both sectors, and especially in importables. The understanding is that the export sector initially was highly dependent on foreign intermediates, but

over time a domestic market developed and the export sector gradually shifted towards domestic intermediates and thereby spread out their learning. A more favorable initial position (larger gap to the frontier) and better linkages to the export sector give a higher rate of labor augmenting technical progress in the importable sector compared to agriculture (see Fig. 2). But even though labor augmenting technical progress is lower in agriculture, the TFP growth rate is higher than in the other three sectors (3.2% on average in agriculture versus about 1.5% in other sectors) because of the exogenous land productivity augmentation. When weighting the sectoral TFP growth rates by the endogenous value added shares, the aggregate TFP growth rate averages about 1.8% during 1960–1998, which is consistent with the Thailand studies referred to above.

The growth process is associated with economic transformation, with declining output share of agriculture and increased share of the export sector. The structural change results from both supply and demand factors in the model. The demand side effect follows from the nonhomothetic utility function. The demand for the agricultural good is income inelastic, and the share of the agricultural good in total consumer spending is declining. At the supply side, increased productivity growth has two opposite effects on employment. First, higher productivity growth allows for maintained growth in production with reduced work force. Second, higher productivity growth reduces the relative price and increases demand and hence expands production. The strength of this last effect depends on the substitution possibilities with foreign goods. To reproduce the actual growth pattern, the expansionary effect must dominate in the export sector, and the employment growth in this sector is high. In agriculture, on the other hand, the labor saving effect dominates.

The structural shift implies labor movements from agriculture to exportables, while the employment shares in both nontradables and importables remain fairly constant over time. Given the combined demand and supply side effects, the agricultural share in real GDP is reduced from 23% in 1960 to 15% in 1998. During the same period the model reproduces an increased share of the export sector in GDP from about 20% to 32% (see Fig. 5 in Section 5). The structural change is an essential part of the learning based growth in our understanding.

5. Counterfactual analysis of openness

The East Asian economies certainly have had focus on export orientation as a development strategy, and their export performance has been impressive. Still there is controversy regarding the importance of the openness of the economies for economic growth. They have shared a high investment level and export promotion policies, and they have gradually progressed into more skilled and technology intensive activities. But the productivity growth anyway is a country-specific experience. Given our model reproduction of the Thai growth path, we can offer a counterfactual analysis throwing some light on the role of openness for the productivity dynamics in this country.

The Thai economy has been outward-oriented, and many analysts have attributed the growth performance to gradual trade liberalization and the access to foreign capital and technology (Karunaratne, 1999; Kochhar et al., 1996 in an IMF study). Our counterfactual assumes constant tariffs equal to 50% for the entire period, and this works as a shock generating new transition growth paths for capital accumulation, TFP and hence GDP that significantly departure from the calibrated reproduction of the actual growth. Given the learning by exporting mechanism formulated, the experiment shows how protectionism may have held back productivity growth and investment. The model produces permanent income and technology level effects of the higher tariffs. While the effect of trade liberalization on Thailand's economy has been investigated in a static general equilibrium framework (e.g., Karunaratne, 1999), we offer an investigation of the dynamic consequences. Three major consequences are represented in the model.

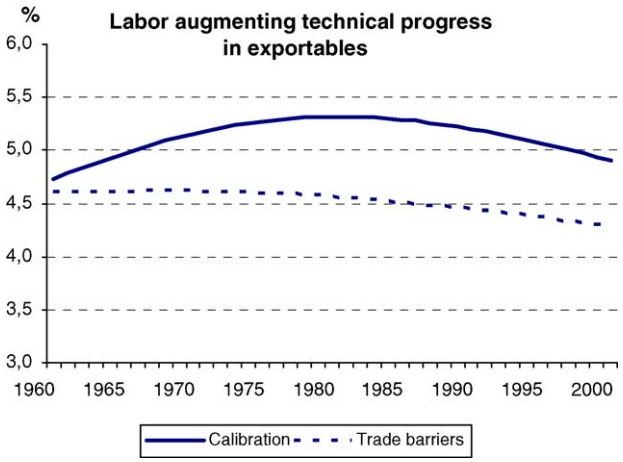

Fig. 3. Labor augmenting technical progress in exportables: calibration vs. trade barriers.

First, reduced openness affects productivity growth directly by increasing the barriers to technology adoption and limiting the transfer of foreign spillovers. Higher trade barriers lower productivity growth in all sectors, but especially in exportables, where imported intermediates and capital goods are employed more intensively. The average technical progress rate in the first 40 years falls by 12%, from 5.1% in the reference path to 4.5% in the barrier scenario (Fig. 3). The degree of technological catch up is reduced, and relative productivity is about 10 percentage points lower at the end of the period compared to the calibrated path (Fig. 4).

Second, higher tariffs increase the cost of investment, and accumulation of foreign capital goods is discouraged. Third, and related to the productivity and investment effects, the structural shift towards exports is held back and affects all sectors. As seen from Fig. 5 the exportable GDP share is lower in the counterfactual scenario. Since tariffs are gradually reduced along the calibrated path, the effect of constant high barriers is strengthened over time. This limits the expansion of the TFP-leading export sector, with significant consequences for overall productivity growth. More expensive goods at the foreign market give the export sector incentives to shift some of

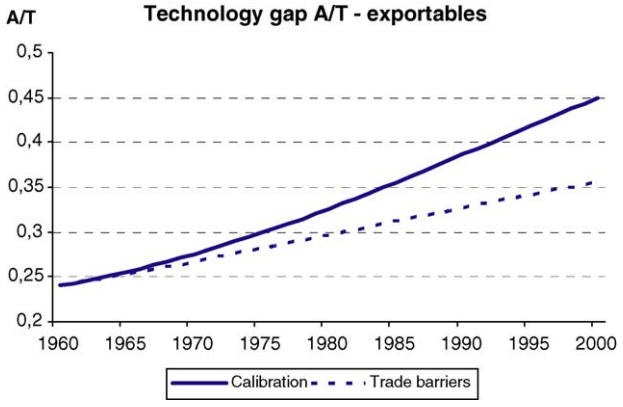

Fig. 4. Technology gap (A/T) in exportables: calibration vs. trade barriers.

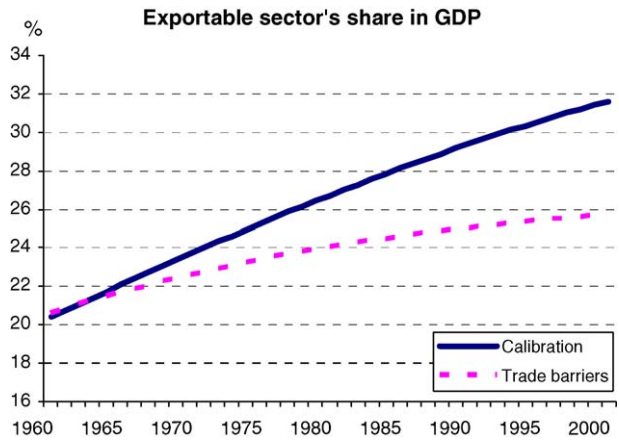

Fig. 5. GDP-share exportables: calibration vs. trade barriers.

its intermediate demand towards domestic producers, generating learning spillovers to the rest of the economy. In the early years this effect counteracts the negative impact of reduced spillovers from abroad, but over time the contraction of the export sector reduces the domestic spillover and productivity growth in the rest of the economy is negatively affected.

The fall in productivity growth, together with a smaller export sector and lower capital accumulation, reduces the average transition GDP growth rate with about 0.8 percentage points compared to the calibrated Thai path. The dynamic productivity and growth effects of trade barriers result from the spillover from the world market, the domestic spillovers from the export sector, and the reduced structural change. In the long-run neoclassical and technological convergence give similar growth rate in the two scenarios. But different transition growth creates a large permanent income gap and lower degree of catch up because of the trade barriers. Fig. 6 shows the development of real GDP per capita in the two scenarios, and with constant higher tariffs per capita income in 1998 would have been about 70% of its actual level in that year.

The negative consequences of tariff barriers follow from the designed growth mechanism of the model. But it seems to us hard to compensate the growth loss of protection by other means. A

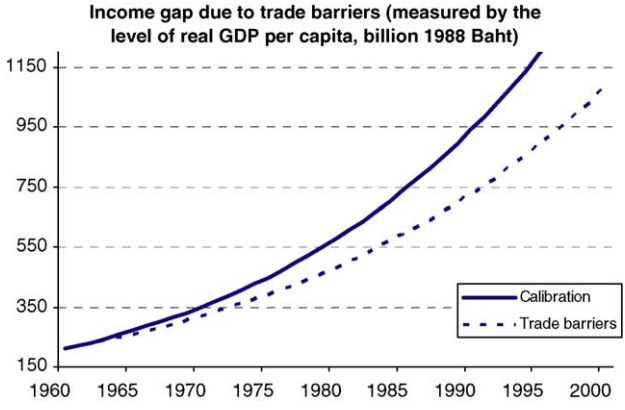

Fig. 6. Income gap due to trade barriers (measured by the level of real GDP per capita, billion 1988 Baht).

protectionist alternative with higher growth must appeal to better domestic sources of productivity growth. In the case of Thailand such an innovation-based alternative growth strategy has not been realistic.

6. Concluding remarks

Understanding the mechanisms behind the remarkable economic growth of almost 8% achieved in Thailand during close to 40 years is the focus of our study. The analysis is motivated by the mechanisms from both new and old growth theory. 'New' long-run productivity growth generation and 'old' investment, structural change and catch up during transition are equally important in explaining the growth performance.

We develop a Ramsey model formulated and calibrated to reproduce the growth path from early-1960s to late-1990s. Learning by exporting is modeled as the main vehicle of productivity growth through international spillover, and the export sector brings further productivity effects to the rest of economy through intermediate linkages. Expansion of exportable industries, together with changes in consumer demand, results in a structural shift from an agriculture dominated economy to an industrialized modern economy, which further enhances the growth. While the econometric literature discusses the causality between exports and productivity, we analyze the endogenous dynamic interaction between exports and productivity. Overall, the study shows how rapid economic growth is prolonged by multi-sector productivity interaction and structural change in this open economy setting.

The importance of openness is developed in a counterfactual analysis, where protection holds back growth by serving as a barrier to international spillovers. Protecting domestic industrial sectors lowers investment and productivity growth in the export sector first and then spills over to the other sectors in the economy. The endogenous productivity growth mechanisms imply that the growth rate of the economy is lowered in the entire time period studied in the model. Without gradual opening of the economy the growth rate is reduced by more than 1 percentage point in the experiment presented, generating a 30% income gap after 40 years. The slow down of the growth rate is accompanied by a slow down of the structural shift and hence exportable sector's contribution to the economy is further weakened. The analysis shows how an economy where productivity growth is based on learning and structural change is vulnerable to trade policy changes.

The importance of openness has been controversial in the debate about the interpretation of East Asia growth. Our contribution is to clarify the dynamic mechanisms of productivity growth based on learning by exporting and show how this can explain prolonged growth. Thailand has had the conditions needed to benefit from openness as a growth strategy stimulating productivity growth and structural transformation. There are multiple channels for developing countries to get access to new technology and hence improve productivity and stimulate growth. We have shown how the exporting sector can play an important role in such a process. Even when the export sector itself is not high-tech, linking with new world technology embodied in imports of intermediates and capital goods may be a feasible strategy for many developing countries. In the present era of globalization and liberalization, this is a more realistic strategy than the bias towards heavy industries and government involvement in Korea and Taiwan in the 1960s and 1970s.

After the growth period highlighted in this paper, Thailand has experienced a serious growth setback with macroeconomic instability. It is of great interest to know whether the economy will return to the high growth path reproduced here or whether the structural conditions for growth has changed. This basic issue concerns the sustainability of growth and in particular of the productivity

mechanism. Observers are worried about the future world market conditions for labor-intensive industries and the lack of emphasis to human capital accumulation and research and development investment. The export-oriented labor-intensive growth success has resulted from a long period of learning, which may have declining return over time. Returning to the recent theoretical analysis of Acemoglu et al. (2005), their challenge of moving into an innovation-based strategy is highly relevant for Thailand now. The investment phase has not been characterized by old firms and government involvement, but transformation to new sources of productivity growth seems to be needed anyway.

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