Learning by Exporting and Structural Change: 
A Ramsey Growth Model of Thailand*

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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 associated with advanced technology or high skill intensity. Our understanding is that Thailand's growth has been based on learning by exporting in labor intensive manufacturing. The analysis using a Ramsey model shows how Thailand has held prolonged growth by structural shift from agriculture to exportables and productivity growth with international spillover. 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.

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1. Introduction

Backward economies can grow out of backwardness when they are able to take advantage of the technology gap to advanced economies. This catching up story is one of the key lessons of development economics and is called the Veblen-Gerschenkron effect. Acemoglu, Aghion and Zilibotti (2002) separate between investment-based and innovation-based strategies in a recent theoretical investigation of the way out of backwardness. 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. Interestingly, Thailand's growth experience does not fit their understanding of the investment phase.

The economic growth in Thailand certainly has been driven by investment and productivity growth, but more based on simple labor-intensive goods than this emphasis 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 productivity improvements associated with international spillovers are more the result of organizational learning. The government has designed an economic structure oriented towards economic openness and foreign investment, and is not characterized by broad based activist intervention (see discussions of the recent history by Jansen, 2001, and Kochar et al., 1996).

We offer an investigation of this different Thailand growth experience and suggest an intertemporal model combining endogenous productivity mechanisms of new growth theory with old growth theory emphasis on investment and structural change during transition. While the econometric literature discusses the causality between exports and productivity, we analyze the endogenous dynamic interaction between exports and productivity. Productivity growth is the result of learning from the international market, not own investments in innovations and human capital. The learning is associated with
exports and also 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 these multi-sector productivity interactions and interacts with capital accumulation and structural adjustment. The model explains the high growth performance as prolonged transition. The background inspiration is the early formalizations of the Veblen-Gerschenkron effect by Nelson and Phelps (1966) and Findlay (1978).

The analysis is based on a general equilibrium Ramsey model with four production sectors; exportables, importables, agriculture and nontradables. In the standard intertemporal small open economy model it is hard to explain high long-term growth. Long run steady state growth rates are assumed to be world normals and transitions are short. Prolonged high growth simulation is the result of foreign and domestic productivity spillovers and structural change, together with slow transition resulting from adjustment costs and Armington goods heterogeneity. The analysis is an extension of Diao et al. (2005), which emphasizes the endogenous interaction of productivity and investment. The key role of the export sector for learning and thereby productivity growth and the associated spillovers are developed here. Stokke (2004) investigates non-linearities in a similar framework. The model is calibrated to reproduce Thailand’s growth experience given the backwardness and catch-up possibilities in the 1960s. The economic structure described represents the conditions for growth established with macroeconomic stability, full employment of resources, open trade regime, and flexible allocation of resources between sectors according to profitability. A counterfactual analysis of protectionist trade policy shows how structural change is important for the catch up and foreign spillover, and protectionism reduces transition growth.

Section 2 puts the analysis in the context of the recent literature on productivity growth. Section 3 outlines the assumed productivity dynamics, and section 4 describes the full intertemporal model. Calibration of the high growth path is presented in section 5, and the sources of growth are decomposed. Section 6 offers counterfactual analysis of openness and structural change, while concluding remarks are offered in section 7.
2. Productivity catch up and learning by exporting

Observers agree that Thailand has achieved high growth over many decades with world market orientation and learning rather than advanced technology and technology innovation. The country faced a large productivity gap towards the industrialized countries and started to grow around 1960. The catching-up advantage of backwardness is called the Veblen-Gerschenkron-effect in the literature, relating to their historical studies of Germany vs. England and Russia vs. England respectively. Economic growth out of backwardness is fundamentally related to productivity growth. The ability of the backward country to generate productivity growth is assumed to be increasing with the size of the productivity gap.

The Veblen-Gerschenkron-effect is first formalized by Nelson and Phelps (1966). They assume exogenous growth of a best practice world technology frontier, and the productivity level of the backward country responds to the productivity distance to best practice. All countries can take benefit of the growth of the world technology frontier, albeit in different degrees and speeds, and dependent on the initial conditions. Nelson and Phelps allow the magnitude of the effect to depend on the education of the labor force, an early introduction of the human capital effect in economic growth. A modern restatement is offered by Parente and Prescott (1994, 2004) using the concept barriers to technology adoption. Improvement in productivity is linked to the distance to the exogenous world technology frontier, and investment is needed to benefit from the world technology. The costs of investment come out as a key determinant of productivity, and the authors see these costs as a barrier resulting from distortions created by policy.

Findlay (1978) offers an early extension of Nelson and Phelps explicitly addressing the technology spillover involved. His main hypothesis is that 'the rate of change of technical efficiency in the backward region is an increasing function of the relative extent to which the activities of foreign firms with their superior technology pervade the local economy'. This is the contagion hypothesis that technology diffusion spreads like a disease with contact. Later theoretical and empirical studies have more generally linked technology
adoption to the openness of the economy. Lee (1995) separates between domestic and foreign capital goods. In his theoretical analysis, capital goods imports promote long-run growth. We exploit this separation both as a distinction between two different capital goods and by having productivity growth associated with imports of capital goods as a spillover. The spillover effect captured in our setup is not interpreted as adoption of advanced technology, but rather as learning.

The inter-sectoral beneficial externalities of the export sector are 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. The learning by exporting clearly involves many aspects of the production process including technological advancement, incentive effects of competition, and transfer of knowledge. Many studies document the empirical significance of imports of machinery and equipment and foreign intermediates. In our analysis, the leading role of exports in the productivity growth is related to the intensive use of imported capital goods and intermediates. The productivity growth in the rest of the economy results from a combination of foreign spillovers and domestic spillover through sales of intermediates to the export sector. Exporting firms gradually raise their use of intermediates from domestic firms and thereby spread out their learning.

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. The article addresses the controversy of causation in the relationship between productivity and exports. Clerides et al. (1998) develop the understanding of export learning and show positive externalities of exporting in data for Columbia and Morocco. The positive relationship between exports and productivity, however, they relate to self election. Bernard and Jensen (1999) investigate the relationship using US manufacturing data and criticize the widely held view that exporting raises productivity. They find that trade facilitates growth of high productivity plants and is not increasing productivity growth in each plant. 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. In the Ramsey model we capture the dynamic interaction between exports and productivity. While learning by exporting stimulates productivity growth, higher productivity affects investment profitability and thereby the export activity.

A broad empirical literature has addressed total factor productivity (TFP) growth and international spillovers. Edwards (1998) investigates the effect of 9 alternative measures of openness on TFP growth in a dataset of 93 countries and finds that more open economies indeed have experienced faster productivity growth. The conclusion is reinforced in a study of East Asian countries by Frankel et al. (2000) taking into account the endogeneity of foreign trade. In a broader study of 77 developing countries Coe et al. (1997) conclude that 'a developing country can boost its productivity by importing a larger variety of intermediate products and capital equipment embodying foreign knowledge'. The estimates document a substantial spillover effect of foreign R&D and that spillovers are linked to trade.

Tinakorn and Sussangkarn (1998) relate annual aggregate TFP growth in Thailand 1981-95 to the capital stock, the openness of the economy, and the sectoral allocation of employment. The effect of the variables can be interpreted as learning by doing driven by domestic factors and foreign spillover, and they all are of statistical significance. Uruta and Yokota (1994) find that TFP growth in manufacturing increases with trade liberalization (measured by effective rates of protection). Rattsø and Stokke (2003) apply the method and the disaggregated data of Tinakorn and Sussangkarn (1998) for agriculture and industry to investigate more closely the dynamics of productivity and foreign spillover (for the period 1975 – 96). Foreign spillovers are assumed channeled through foreign trade and foreign direct investment (in industry). They observe a strong and fairly robust long-run relationship between openness and productivity in both domestic sectors during a period of increasing trade share of GDP and foreign investment share of investment. The foreign spillover channel explains more than 80% of the TFP growth in agriculture and about 75% of industrial TFP growth during 1975 – 96. The calibration below is based on this empirical evidence.
3. Productivity dynamics

Productivity growth is generated through foreign and domestic productivity spillovers. International spillovers combine two elements, the distance to the world technology frontier defining the potential productivity level and the role of barriers. We apply the modified Nelson-Phelps specification suggested and empirically tested by Benhabib and Spiegel (2003). 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. Nelson and Phelps (1966) and Benhabib and Spiegel (2003) 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). Rattsø and Stokke (2004) 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.

To capture the important role of the export sector in the learning process we apply a four-sector framework with a separate growth-leading export sector in addition to importables, agriculture and nontradables. The disaggregation allows for an investigation of sectoral interlinkages and their contribution to economic growth. Learning by exporting is built in as the main vehicle of international spillover. 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 the rest of the economy.

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

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

(1)

\[
\frac{\dot{A}_{j}}{A_{j}} = \lambda_{1,j} \left( \frac{N_{M,j}}{GDP} \right)^{\gamma_{1,j}} \left( \frac{K_{M,j}}{GDP} \right)^{\gamma_{2,j}} \left( 1 - \frac{A_{j}}{T_{j}} \right) + \lambda_{2,j} \left( \frac{Ne_{j}}{GDP} \right)^{\gamma_{3,j}}, \text{ for } j = ag, \ im.
\]

(2)

where \(i = ag, ex, im\) represents agriculture, exportables and importables, respectively. Productivity growth in nontradables is assumed to grow exogenously at the long run rate. \(A_{i}\) and \(T_{i}\) are the domestic and frontier level of productivity in sector \(i\), respectively, and \(\left( 1 - \frac{A_{i}}{T_{i}} \right)\) is the productivity gap. \(N_{M,i}\) represents total imported intermediate goods employed by sector \(i\), \(K_{M,i}\) 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 \(\lambda_{1}, \lambda_{2}, \gamma_{1}, \gamma_{2}\) and \(\gamma_{3}\) are constant parameters.

Under symmetric growth, the long-run productivity growth is given by the exogenous 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:

\[
A_{ex} = \frac{\lambda_{1,ex} \left( \frac{N_{M,ex}}{GDP} \right)^{\gamma_{1,ex}} \left( \frac{K_{M,ex}}{GDP} \right)^{\gamma_{2,ex}} - g}{\lambda_{1,ex} \left( \frac{N_{M,ex}}{GDP} \right)^{\gamma_{1,ex}} \left( \frac{K_{M,ex}}{GDP} \right)^{\gamma_{2,ex}}} \cdot T_{ex}
\]

(3)

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

\[
A_{j} = \frac{\lambda_{1,j} \left( \frac{N_{M,j}}{GDP} \right)^{\gamma_{1,j}} \left( \frac{K_{M,j}}{GDP} \right)^{\gamma_{2,j}} + \lambda_{2,j} \left( \frac{Ne_{j}}{GDP} \right)^{\gamma_{3,j}} - g}{\lambda_{1,j} \left( \frac{N_{M,j}}{GDP} \right)^{\gamma_{1,j}} \left( \frac{K_{M,j}}{GDP} \right)^{\gamma_{2,j}}} \cdot T_{j}
\]

(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 and Ventura, 2002).

4. The Ramsey model

The productivity dynamics is built into a standard intertemporal Ramsey growth model for a small open economy. The model setup of Diao et al. (2005) is the starting point, but is extended to capture domestic productivity spillovers and structural aspects of the Thai growth process. In the small open economy capital accumulation and productivity growth do not influence world prices and interest rate, which are exogenously given. 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. Early applied Ramsey models include Goulder and Summers (1989), who study tax policy effects on investment in the US, and Go (1994), who applies the model framework on development issues. Detailed documentation of the intertemporal general equilibrium model is given in a separate model appendix available from the authors.

The economy consists of four sectors: agriculture, exportables, importables and nontradables. The original Social Accounting Matrix is developed by the National Economic and Social Development Board (NESDB) in Thailand, and includes 61 commodity groups. The aggregation into the four sectors is based on export and import intensity in production and demand, respectively (except for agriculture which is defined by production characteristics). We define a nontradable product group with export-output and import-sales ratios both below 20%. The rest of the non-agricultural product group is aggregated into exportable and importable sectors based on relative export and import intensity. Exportables has an export-output ratio of 43% on average, and accounts for 2/3 of total exports in the economy. Total sales of the exportable good consist of about 25%
imported goods. For the importable product group foreign goods accounts for 40% of sales, while the export-output ratio is 20% on average. Obviously, the sectoral aggregation implies that all the four sectors included in the model are have tradable elements. However, the role of imports and exports is significantly different across sectors, which allows us to study the dynamic linkages between trade and growth through export learning and import technology spillovers.

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.

Imports in the model are distinguished by different uses, i.e., imports for final consumption, intermediate inputs, or investment demand. There is imperfect substitution between domestic and imported consumption and intermediate goods (through the Armington functions), while domestic and foreign investment goods are separated. In addition, as exports are possible in all the four sectors, a CET function is used to capture the imperfect substitution between goods produced for the domestic markets versus for exports.

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. With a waste due to adjustment costs in investment, net profits as returns to capital go to the household sector. Differentiating the intertemporal profit function with respect to domestic and foreign capital gives us the well-known no-arbitrage conditions:

\[ r \cdot q_{k,j-1} = Rk_{k,j} + a_k \cdot PD_{mf,t} \cdot \left( \frac{I_{k,j}}{K_{k,j}} \right)^2 - \delta_k \cdot q_{k,j} + \hat{q}_{k,j} \]  

(5)
where $k = D, M$ represents domestic and foreign, respectively. The condition in (5) 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, $R_{k,t}$, 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, $\delta_k$, and capital gain or loss, $q_k$.

Investments can be financed through foreign borrowing, and the decisions about savings and investment can therefore be separated. Domestic savings and investments do not have to be equal in each period, but a long-run restriction on foreign debt exists. 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.

The representative household allocates income to consumption and savings to maximize its intertemporal utility. There is no independent government consumption and saving, and all government tax revenues, including import tariffs and sales taxes, are transferred to the household lump sum. 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:

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

where $r$ is the exogenous world market interest rate, $\rho$ the positive rate of time preference, $\sigma$ the intertemporal elasticity of substitution, $Q_t$ aggregate consumption in period $t$, and $PQ_t$ is 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.

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. With positive foreign debt the country has to run trade surplus.

5. Calibration of Thailand’s growth path

The model is calibrated to reproduce Thailand’s high growth experience 1960-98. As explained in the introduction, 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 1961-98 equals 2.6% (World Bank, 2001). The growth rate is significantly lower in the 1990s compared to earlier periods (probably held down by the Asian crisis). Based on this we assume a long-run labor growth rate of 3%. Growth accounting analyses of Thailand, documented in Collins and Bosworth (1996), Tinakorn and Sussangkarn (1998) and 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 TFP growth the past decades has been well above world normals, 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 parameters supporting the long-run equilibrium path are discussed in the appendix.

Starting from the base year 1998, we calibrate backward a growth path that is close to the observed real GDP growth for the previous four decades. To reproduce the actual GDP of 1960, the initial level of capital stocks is reduced to about 4 percent 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 productivity dynamics assumes that the initial productivity gap is much larger than the long-run equilibrium gap. 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 economic transition is accompanied by gradual reduction of import tariffs based on historical data. Sectoral tariff rates (relative to import) fall gradually from 30 percent in 1960 to about 5 percent 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.

The calibrated transitional growth varies over time and is generally declining. On average during 1960-98 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 Figure 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.

Figure 1 about here

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. Foreign capital accumulation not only stimulates overall investment growth, but also is an important channel for productivity spillover.
Increasing productivity growth provides another engine of growth, beside capital accumulation, and such growth is further sustained through increased exports that expand spillovers.

As explained in section 3, productivity growth in exportables resulted from foreign spillovers embodied in imports of intermediates and capital, and this further induces learning and hence spillovers to the rest of the economy. While the rest of the economy benefits from foreign spillover, the driver of the growth is the exportables sector, where the growth effect of international spillovers is set relatively high. The specification is consistent with the productivity convergence theory, in which 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. Prolonged high growth of foreign capital goods, together with gradual reduction of tariffs stimulating intermediate imports, explains the initial increase in productivity growth. The magnitude of the spillover effect declines over time and gives a concave growth 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. Figure 2 illustrates the sectoral paths of labor augmenting technical progress. The TFP growth paths follow similar patterns, but at a lower level. With a labor share of 0.26 (consistent with 1998 data for exportables) the average TFP growth rate during 1960-98 equals 1.3%.

The reproduction of the actual productivity path is based on available data. Hall and Jones (1999) estimate the productivity level in Thailand to about 50 percent 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. But since Thailand’s growth process has been characterized by labor-intensive low-
tech industry, we do not expect a similar catch-up with regards to the technological level and relative productivity in exportables is calibrated to increase from 0.25 to 0.45 during 1960-98 (illustrated in Figure 4 in section 6).

Figure 2 about here

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 Figure 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 1960-98. This is consistent with conventional TFP calculations for Thailand, documented in Collins and Bosworth (1996), Tinakorn and Sussangkarn (1998) and Young (1994), which tend to identify productivity growth in the order of 2%.

The economic transformation occurs with growth, and the role of agriculture diminishes over time. This is captured by a declining share of agriculture and increased share of the exportables sector. The structural change results from both supply and demand factors in the model. The demand side effect follows from the non-homothetic utility function. With a Stone-Geary type utility function, demand for the agricultural good is income inelastic, and the share of the agricultural good in total consumer spending is declining. With both 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 Figure 5 in section 6). The calibration of exportable value added share is broadly consistent with data, while the actual decline in agriculture was larger than captured by the model. Historical data\(^1\) with similar sector disaggregation is available for the 1975-98 period (but not from 1960), and shows a reduction in agriculture from 24% to 15% and an increase in exportables from 23% to 32%.

The structural shift implies labor movements from agriculture to exportables, while the employment shares in both nontradables and importables remain fairly constant over time. Increased productivity growth has two opposite effects on employment. First, higher productivity growth allows for maintained growth in production with reduced workforce. 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 demand for agricultural goods is income inelastic and the employment share in agriculture falls over time.

6. Counterfactual analysis -- reduced openness

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, and Kochhar et al., 1996 in an IMF study). The consequences of increased trade barriers via structural change and multisectoral spillovers are investigated in a counterfactual experiment assuming constant tariffs equal to 50% for the entire period. With this shock, the model generates new transition growth paths for capital accumulation, TFP and hence GDP that significantly departure from the

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\(^1\) Input-Output tables provided by the National Economic and Social Development Board (NESDB) in Thailand.
calibrated reproduction of the actual growth. The productivity dynamics together with structural adjustment generate permanent income and technology level effects of increased 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.

Given our productivity specifications, 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 percent, from 5.1% in the reference path to 4.5% in the barrier scenario (Figure 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 (Figure 4).

Figure 3 and 4 about here

The structural shift towards exports is held back and affects all sectors. As seen from Figure 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. Higher tariffs increase the cost of investment, and accumulation of foreign capital goods is discouraged. 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 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. Figure 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.

7. Concluding remarks

Understanding the mechanisms behind the remarkable economic growth of almost 8 percent 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 long-run growth rate is reduced by more than one 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 catch-up and learning by exporting can be significantly affected by trade policy and the importance of openness for growth.

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. (2002), 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.
References


World Bank (2001), World Development Indicators.

Appendix: Calibration

The parameters in the production, demand, and trade functions are set according to the method adopted in most static computable general equilibrium models and are based on the 1998 social accounting matrix (SAM) documented in a separate model appendix available from the authors. The original SAM includes 61 production sectors, which are aggregated into four sectors according to trade-production ratio (except for agriculture which is defined by production characteristics). The calibration assumes long run balanced growth, i.e. the savings-investment can support a sustainable growth path, the structure of the economy is stable, and the trade surplus with interest payments balances the projected development of foreign debt. The SAM is consistent with such an equilibrium, except for that the investment level has been adjusted up (depressed by the Asian crisis). The long run growth path calibrated as supply side response to sectoral investment and productivity adjustment must be made consistent with the macroeconomic equilibrium as represented by the Euler equation:

\[ r = (1 + \rho)(1 + g + n)^\sigma - 1, \]

where \( g + n \) is the exogenous long-run growth rate. Given intertemporal elasticity of substitution of 1.5, a world market interest rate of 14 percent and long-run growth rate of 6.5 percent, the time preference rate is equal to 5 percent. Marginal product of both domestic and foreign capital is assumed to be 0.18, while the depreciation rate is set to 0.035. Then, with the long run assumptions, most parameters of the intertemporal part of the model can be calibrated from the SAM. Given marginal product of capital, the initial capital stocks are calculated based on capital income. Land use in agriculture is assumed to account for 50 percent of total agricultural capital stock. Investment is calibrated from the long-run constraint on capital accumulation, for given values of depreciation rates and long run growth rate. The shadow prices of capital equal the firm value relative to the capital stock, and follow when we know the interest rate. The initial level of foreign debt is set by the long-run constraint on debt accumulation, given data about trade deficit/surplus together with the long-run growth rate and interest rate. The \( \gamma \) values allocate the effects of foreign and domestic spillovers, and we assume that \( \gamma_2 \) is greater than \( \gamma_1 \), implying relatively larger spillover effect of imported capital than of imported intermediates (with 2/3 and 1/3 weights respectively). Exportables is assumed to benefit relatively more from foreign spillovers with \( \gamma_1 \) equal 0.35 and \( \gamma_2 \) equal 0.65, while for the rest of the economy \( \gamma_1 \) and \( \gamma_2 \) are set to 0.25 and 0.5, respectively. The impact of domestic spillovers through linkages to the export sector is measured by the parameter \( \gamma_3 \), and is assumed to equal 0.3. In the calibration domestic spillovers is assumed to contribute to 30% of the steady state growth rate. From this assumption we calibrate \( \lambda_2 \). Based on the long run rate of technological progress, initial values of the spillover variables and the long-run technology gap, the \( \lambda_1 \) parameters follow as a residual.
Figure 1. Real GDP growth rate: Calibrated path of model vs. actual growth (measured as 5-year moving average)

![Real GDP growth: data vs model](chart1.png)

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

![Sectoral labor augmenting technical progress](chart2.png)
Figure 3. Labor augmenting technical progress in exportables: calibration vs. trade barriers

Figure 4. Technology gap in exportables: calibration vs. trade barriers
Figure 5. GDP-share exportables: calibration vs. trade barriers

Figure 6. Income gap due to trade barriers