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Abstract

This paper revisits the analysis of the implications of China's economic growth on her trading partners presented in Arndt *et al.* (1997) using a dynamic, applied general equilibrium model that features international capital mobility. We find that accounting for the impact of China's growth on international capital markets reverses some of the findings in the paper by Arndt *et al.* In particular, net creditor regions lose while net debtor regions benefit from an economic slowdown in China due to the resulting decline in the cost of capital. Our analysis also reveals the importance of capital accumulation effects which interact with non-capital factor productivity and tax distortions in determining regional welfare.

Key words: China, growth, international capital mobility

Contents: 1. Introduction. - 2. Model Description. - 3. Simulation Design. - 4. Baseline Results. - 5. Welfare Analysis of China's Economic Slowdown. - 6. Conclusion.

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1 Introduction

In a recent article, Arndt *et al.* (1997) provide a systematic analysis of the impact which rapid growth in China is likely to have on other economies over the next decade. Using the comparative-static GTAP applied general equilibrium model (Hertel and Tsigas, 1997), the authors trace the sources of gains and losses to individual welfare components using a decomposition technique developed by Huff and Hertel (1996). That study finds that, if only net trade positions are considered, China's growth appears to adversely affect non-OECD countries. However, when all effects, including changes in region-specific export and import prices, allocative efficiency and endowment effects, are evaluated 12 out of 14 non-China regions are expected to benefit.

While the paper by Arndt *et al.* (1997) offers some valuable insights, it suffers from a number of limitations. The modeling framework in this earlier study does not offer an adequate treatment of investment, capital mobility and capital accumulation, which could play an important role. In addition, their model does not distinguish between regional capital and wealth, or between gross domestic and gross national product, and thus, it does not adequately reflect the welfare effects of foreign capital ownership. Since rapid economic growth and trade liberalization may affect the capital and current accounts through changes in investors' expectations, and therefore capital flows, it is important to re-consider the issues discussed in Arndt *et al.* in a dynamic framework offering an improved macroeconomic representation of these factors.

The study by Arndt *et al.* is based on World Bank's projections formulated in the early nineties. Since then changes in the world economy have affected the actual growth of the Chinese economy and the outlook for the region over the next decade. For example, while in

Arndt *et al.* the Chinese economy is projected to grow at an average annual growth rate of 9.2%, China's actual growth rates in 1997 and 1998 were lower than this projected rate (8.8% and 7.8%, respectively). In addition, the recent crisis in East Asia prompted the World Bank (1998) to lower its forecast of the average growth rates in China for the period 1992-2005 from 9.2% to 8.7%. Given all these changes in the economic outlook for China, our intention is not to conduct a comprehensive model validation exercise, which would compare predicted versus actual outcomes. Our objective is more modest – namely, examine the sensitivity of the Arndt *et al.*'s findings to the presence of capital mobility.

The recent crisis in Asia has also prompted many economists to think about the impact of slower growth in China on the rest of the world. Consequently, instead of looking at the case of rapid growth in China, discussed in Arndt *et al.*, we explore the case of China joining the rest of Asia in an economic slump. We use a dynamic multi-region applied general equilibrium model. It features a novel theory of adaptive expectations, international capital mobility, foreign capital ownership and foreign income accounting. The investment theory in the model has considerable merit as a depiction of investment behavior and offers greater empirical realism over the methodology used in Arndt *et al.* The dynamic nature of the model enables us to generate time paths, end-of-period results, and accumulation effects (Baldwin, 1989), not captured endogenously by Arndt *et al.* In medium- to long-run simulations, a dynamic model is also the most natural setting for modeling wealth accumulation. Finally, unlike Arndt *et al.*, we keep track of capital ownership by extending the accounting framework of the model to accommodate net foreign income.

We find that an economic slowdown in China results in a welfare loss to the largest creditor regions, Western Europe and Japan, primarily due to lower return on capital. On the other hand, large debtors, such as the United State and Latin America, enjoy welfare

gains as the lower cost of capital implies lower debt payments. In addition to this "financial effect", our welfare analysis also captures the welfare effects arising from the interaction of the 'Baldwin' type accumulation effects with non-capital factor productivity and tax distortions in the domestic economy. This, too, was omitted from Arndt *et al.*'s analysis.

2 Model Description

To emphasize the importance of international capital mobility and ownership treatment, for comparison purposes, our model introduces new investment methodology while retaining the other features of the GTAP model used in Arndt *et al.* More specifically, we preserve GTAP's perfectly competitive market structure, CDE consumer demand representation, constant-returns-to-scale technology, as well as the model's ability to capture the interaction between differential rates of factor accumulation and sectoral factor intensities giving rise to the so-called 'Rybczynski' effects.[1] In this section we discuss the innovations introduced in our model to shed light on the implications of China's growth for international capital mobility. These include introducing international financial assets, capital ownership and a new investment theory.

2.1 Financial Assets, Capital Flows and Income

Equity in domestic enterprises W_D and equity in enterprises located in foreign regions W_A comprise regional wealth W, measured in dollar terms:[2]

$$W = W_D + W_A. \tag{1}$$

[1]For details, please refer to documentation of the GTAP model (Hertel and Tsigas, 1997).

[2]For notational convenience, we have omitted regional indexes.

Over time regional savings, which are a fixed share of income, augment regional wealth W:

$$\dot{W} = S. \tag{2}$$

Due to an absence of data on bilateral investment flows, we do not model bilateral equity ownership, instead we assume that regional households invest abroad via a global investment trust. The global trust represent foreign investors. It collects the savings that regional households have chosen to invest in foreign regions and invests these funds on their behalf. The investment theory determines how the trust allocates funds across regions.

Since regional households earn income, not from the capital stock they harbor, but from the capital stock they own, the model takes separate account of capital and wealth accumulation by region. The total equity of the domestic economy V, measured in dollar terms, consists of equity in domestic enterprises owned by domestic investors W_D and equity in domestic enterprises owned by foreign investors W_F:

$$V = W_D + W_F. \tag{3}$$

Over time net regional investment augments regional capital K:

$$\dot{K}(t) = I(t) - \delta K(t), \tag{4}$$

where regional investment $I(t)$ is funded both by domestic and foreign sources. Capital has the same productive characteristics regardless of its age and depreciates at an exponential rate. As in Arndt *et al.*, we do not distinguish between debt and equity investment. All foreign funds are used for purchases of physical investment goods, which are then added to the existing stock of physical capital.

We assume that each region specializes in its own assets. The composition of regional wealth and domestic capital change as needed to be consistent with the level of regional

savings and investment determined elsewhere in the model. Regional households earn income both from their domestic and foreign equity. The model's investment theory, given by a set of partial differential equations describing investors' behavior, is discussed next.

2.2 Dynamic Investment Theory

The dynamic investment theory used in this study offers a novel disequilibrium approach to modeling international capital mobility. This approach offers a number of advantages over perfect foresight models including: greater empirical realism, greater flexibility in data specification, greater regional and sectoral disaggregation, reduced problem size, and lower computational complexity. According to this theory, investors respond to expected, not actual rates of return, while the errors in investors' forecasts of the actual rates of return are akin to those recently witnessed in Asia.

In each region there is a target (gross) rate R_t. The target rate of return equals the global rate of return that clears the global market for capital. To reflect inter-regional differences in returns due to different investment risks, we adjust the target rate of return with a region-specific risk premium.[3] Investment supplied to each region is such as to achieve some required rate of growth $\Gamma \stackrel{\text{def}}{=} \dot{R}/R$ in the rate of return R_a:

$$d\Gamma = \Lambda(\hat{R}_t - \hat{R}_e). \tag{5}$$

where Λ is a parameter determining the speed of adjustment in the expected rate of return towards the target rate, and R_e is the expected rate of return.[4] Since investors typically expect to derive returns over some considerable period of time, they are concerned not only

[3] In the absence of risk premia, the target rate is uniform across regions.

[4] The operators d and $\hat{}$ denote a change and a proportionate change, respectively.

with the rate of return at the moment of investing funds, but also with the rate of return through the life of the asset. Therefore, it is the expected return in future periods, R_e, not the actual return to which investors respond. Equation 5 determines the required rate of growth Γ so that the expected and target rates of return change at the same rate. If the expected rate of return R_e falls short of the target rate R_t, the required rate of growth in the rate of return Γ becomes positive. Conversely, if the expected rate of return R_e exceeds the target rate R_t, the required rate of growth in the rate of return is negative.

To determine the regional composition of investment, we impose equality between the actual and required rates of growth in the rate of return. Thus, Γ varies inversely with the actual rate of growth in the capital stock and directly with the normal rate of growth in the capital stock Ω:

$$d\Gamma = -\phi \left(\frac{I}{K} \left(\frac{\widehat{I}}{K} \right) - d\Omega \right), \tag{6}$$

The normal rate of growth in the capital stock is that rate of growth in the capital stock that allows the rate of return to remain constant through time. If there is a discrepancy between the estimated and the normal rate of growth in capital stock, Ω will change as specified by the following equation:

$$d\Omega = \eta \left(\hat{K} + \frac{\widehat{R_a}}{\phi} - \Omega dt \right). \tag{7}$$

This relationship is such that the normal rate of return adjusts towards the estimated rate of growth in capital stock $\hat{K} + \widehat{R_a}/\phi$ at a speed determined by the parameter η.

Investors' expectations are "sticky" or "sluggish." When the observed rate of return changes, investors are unsure whether this change is transient or permanent. They adjust their expectations of future rates of return only with a lag. At first investors make a small adjustment, then if the change in the actual rate persists, they make further changes in

expectations, until eventually the expected rate conforms to the observed rate:[5]

$$\hat{R}_e = -\phi(\hat{K} - \Omega dt) - \mu log\frac{R_e}{R_a}dt. \tag{8}$$

If the expected rate of return equals the actual rate ($log(R_e/R_a) = 0$), and the capital stock is growing at the normal rate ($\hat{K} = \Omega dt$ or $\frac{I}{K}\widehat{\frac{I}{K}} = d\Omega$), equations (8), (6) and (5) imply no change in the expected rate of return R_e, the required rate of growth in the rate of return Γ, and the target rate of return R_t, respectively.

If expected and actual rates of return are equal, but capital stock is growing more rapidly than the normal rate of growth in capital stock, then the expected rate of return adjusts in a downward direction as specified by equation (8). This signals an increase to the required rate of growth in the rate of return via (5), and thereby a decline in the actual rate of growth in capital stock and investment via (6).

If capital stock is growing at the normal rate, but the expected rate of return exceeds the actual rate, then again the expected rate of return moves in a downward direction as determined by (8). Equation (5) prompts an increase in the required rate of growth in the rate of return Γ, and via (6), a decline in the regional investment and the actual rate of growth in the rate of return. Next period, the expected rate of return adjusts because of the discrepancy between the actual and expected rates of return and the decline in the actual rate of growth in the capital stock. As the normal rate of growth follows the actual rate of growth in capital stock in its decline via (7), the system moves towards equilibrium characterized by the following:

$$R_e = R_t = R_a, \tag{9}$$

$$\dot{\Omega} = 0,\ \Omega = 0 \tag{10}$$

[5]Ianchovichina (1998) provides complete derivations of these equations.

$$\dot{R}_e \quad = \quad \dot{R}_t = \dot{R}_a = 0. \tag{11}$$

Equations (5), (6), (7) and (8) comprise the disequilibrium investment theory of the model with adaptive expectation and determine regional supply of investment funds. In this application, we assume perfectly elastic regional demand for investment funds. In other words, we assume that the investment process is not associated with waste of the purchased investment goods or any other type of adjustment costs during installation (Ianchovichina *et al.*, 1999).

3 Simulation Design

For comparison purposes, we construct the simulations following as closely as possible the experimental design and data used in Arndt *et al.* (1997). As in this earlier study, the data base is a version 3 GTAP Data Base (McDougall, 1997) aggregated to 15 regions and 10 sectors (Tables 1 and 2), with a supplementary disaggregation of skilled and unskilled labor. It combines detailed bilateral trade, transport and protection data characterizing linkages among regions, together with individual country input-output tables, which account for inter-sectoral linkages within regions. The input-output structure of the data base captures differences in intermediate input intensities, as well as import intensities by use.

The treatment of foreign capital ownership and the investment theory in the model requires the addition of new data on financial equity owned by domestic residents in the domestic economy and abroad, and foreign owned equity located in the domestic economy. We constructed these data from information on exports and imports of factor services published by the World Bank in World Tables (1992).[6] A number of parameters, determining

[6]Ianchovichina (1998) presents details about the construction of these data.

the speed of adjustment in the set of partial adjustment equations, are also specified.[7] We estimate the perceived elasticity of the rate of return ϕ in a calibration simulation. We assume that the perceived elasticity equals the actual one, which we compute as the ratio of the percentage changes in the actual rate of return and capital stocks.

The base scenario in this study is a projection of the growth of the world economy for the period 1992-2005 as implemented in Arndt *et al.* It provides for growth in factor endowments, implementation of the Uruguay Round trade agreement, and technological change shocks. We calibrate the technical change parameters so that we achieve growth in regional GDP and capital stocks, consistent with the estimates of the World Bank used in Arndt em et al.. We apply the World Bank's projections for population, labor and human capital,[8] shown in Table 1, as exogenous shocks at constant annual rates over the simulation period. Unlike Arndt *et al.*, our model determines capital stocks via explicit capital accumulation given by equation (4). We base our estimates of sector and factor neutral total factor productivity (TFP) growth rates on projected growth in factor inputs and the World Bank's

[7] We set the parameter μ and Λ, at 0.4 in all regions. This implies, for example, that if the expected rate of return exceeds the actual rate by 1.0 percentage points (e.g. the expected rate of return is 12 per cent per year, while the actual rate is 11 per cent), then *ceteris paribus* the expected rate of return declines at a rate of (about) 0.4 percentage points per year. The expected rate of return does decline by about rather than exactly 0.4 percentage points because the error correction mechanism is expressed in logarithms rather than percentage differences. We set the parameter determining the speed of adjustment in the normal rate of growth in the capital stock, η at 0.2 for every region. This means that investors seek to adjust capital stocks faster than they revise their estimate of the normal capital stock growth rate. We can show that lower value for the parameter η than parameter Λ is desirable for the stability of the dynamic model.

[8] In each region, the projected growth in human capital far exceeds that in raw labor. These projections are based on the growth in the stock of post-secondary educated labor in each country during the 1980-87 period (Nehru, Swanson, and Dhareshwar, 1993).

real GDP projections. We assume that TFP growth rates in the agricultural sector are slightly higher than for nonagriculture (0.7%/year), as suggested by Bernard and Jones (1993). Our baseline incorporates the Uruguay Round agreement via cuts[9] in tariffs, tariff equivalents and export subsidies with accelerated quota growth in textiles and apparel as specified under the agreement on Textiles and Clothing (Hertel, Martin, Yanagishima, and Dimaranan, 1995).

We solve the model in an iterative fashion. This produces a sequence of results representing yearly percentage changes in variables. Each period, the solution to the model obeys the restrictions imposed by the economic theory. Consumer demands exhaust regional spending, regional output determines the household's income, exports plus transport margins must equal imports, and the sum of capital stock around the world equals total accumulated wealth.

4 Baseline Results

We summarize the baseline results by examining the change in the composition of value added (at constant prices). Since these results follow closely Arndt *et al.*, here we focus our discussion on China (Table 2).

The baseline exposes the shift between industrial and rural economic activities in China. This country's light manufacturing sector expands its share in value-added by 28.9%. The expansion of the transport, machinery and equipment and heavy manufacturing sectors is even stronger, with the transportation sector increasing its share in value-added by more than 55%. The services sector also expands due to the inflow of capital, which comprises 76% of

[9]WTO's Integrated Data Base (Reincke, 1997) is the main source for computing these cuts.

all factor endowments used in this sector. As it declines in relative importance by more than 18%, agriculture in China releases resources enabling the expansion of all manufacturing sectors. This in turn fuels the surge in exports from China to the rest of the world, as shown in the second column of Table 2. Notably high are cumulative (13 year) increases in Chinese exports of light manufactures (323%), transport, machinery and equipment (456%), and heavy manufactures (380%). Chinese imports also grow rapidly with highest increases in processed food and textiles.

The base case results reveal that the largest increases in exports from China are in light manufactures, as also shown in Arndt *et al.*, and transport, machinery and equipment. The large increase in the export volume of light manufactures is due to high levels of 1992 exports (1992 US$ 21,612 millions) coupled with large percentage increases in exports (314%). The composition of Chinese exports reinforces the belief that rapid growth (slowdown) in China might jeopardize (facilitate) the chances of many developing countries to further their industrialization by using the North American and Western European markets as primary destinations for their products. For example, China directs the majority of the increase in light manufacturing exports towards North America (US$19 billion) and Western Europe (US$28 billion, Table 6 in appendix). The increase in the export volume of transport, machinery and equipment is largely due to large percentage increase in these products' exports (443%). China directs the majority of these exports towards Hong Kong (US$21.9 billion), Western Europe (US$13.1 billions) and North America (US$11.6 billion).

The results for bilateral imports (Table 7 in appendix) suggest that the highest increases in China's import volumes of these products are from North America, Hong Kong, Western Europe, Japan, Korea, and Taiwan. Thus, trade between China and the industrialized world is expected to intensify. This leaves the developing world to export primarily processed food,

textiles, and natural resource products to the Chinese market.

In addition to the trade effects, this study captures the impact of China's slowdown on the world market for capital. China's economic slowdown puts a downward pressure on the demand for capital worldwide, as its growth is financed in part by foreign investment. This translates into lower rates of return to capital globally and cheaper capital for the other developing regions, which also depend on foreign capital inflows for their development. Thus, the financial effects reinforce the trade effects suggesting that slowdown in China might have positive effect for the developing world. The next section provides a rigorous analysis of these issues.

5 Welfare Analysis of China's Economic Slowdown

To assess the likely impact of China's economic slowdown on other regions, the alternative scenario features a uniform factor productivity decline in China from 6.38 to the world's average excluding China (-0.02) after 1997. It leads to lower productivity of all China's primary factors of production, and therefore, to slower growth of China compared to the base case. We use cumulative differences of the results from these two simulations to assess the likely impact of China's slow growth on other regions.[10]

The lower productivity of China's primary factors of production is manifested in a substantial decline in capital earnings. The decline in earnings leads to a drop in the rate of return to capital relative to the baseline after 1997. By 2005 the rate of return to capital in the region is about 13% lower compared to the base case. This means that the average

[10]The cumulative difference in a given variable measures cumulative change from base case, i.e. how much the percentage change in a variable in the alternative case differs from the percentage change in the same variable in the base case.

rate of return drops from 10.2% to 8.8%. Figure 1 shows the time profile of the cumulative differences in the rate of return to capital in China. In response to these developments, investors adjust their expectations in a downward direction (via equation (8)) and reduce their investments in China (via equations (5)) and (6)). Consequently, investment in China slows down and, by 2005, it is about 86% lower than the base case (Figure 1) The capital accumulation equation (4) translates lower investment into lower capital stocks in China. By 2005, regional capital stocks are almost 37 percent below their baseline levels (Figure 1).

Slower growth in China lowers capital inflows (a cumulative decline of US$ 751, relative to the base case, by 2005) into the region. The increased abundance of investment funds in the rest of the world lowers world cost of capital.[11] Table 3 shows the impact of China's slower growth on the rest of the regions' welfare. The first column and second columns of this table display comparative dynamic results for regional utility (in percentage terms) and equivalent variation (in millions of US$), respectively. These results are cumulative differences from the base case in 2005.[12] Results in columns 3 through 7 are the individual components of the equivalent variation and sum up (within rounding precision to the first digit) to the equivalent variation results in column 2. This decomposition is a modified version of the welfare decomposition for the standard GTAP model (Huff and Hertel, 1996),

[11] Quantitatively these declines in the rates of return are small, varying between 0.3% and 1.8%.

[12] We consider utility changes at the same point in time. Therefore, the notion of welfare change in this dynamic model is very similar to the notion of a welfare change in a comparative static model. We motivate this approach with the fact that economic agents in the model maximize static, not intertemporal utility, and a discount factor determining the time rate of preferences is not present. The drawback of this approach is that it leads to difficulties in interpreting the welfare results in cases when base and alternative simulations differ substantially. However, to compare utility changes over a given period of time, one would need to construct discounted utility measures.

which also includes a financial effect.[13]

Unlike Arndt *et al.*, who report that all but one region's welfare is positively correlated with growth in China, we find that the welfare of a number of regions is inversely related to growth in China. Therefore, their utility increases due to an economic slump in China. Table 3 reveals that a number of developing regions, namely Thailand, Latin America, Philippines, and South Asia, benefit from the slowdown. The economies of Japan and Hong Kong, followed by Western Europe and the Rest of the World, realize the greatest absolute losses (Column 2, Table 3). The largest losses accrue to Hong Kong, followed by Malaysia, Taiwan, Korea, Rest of the World and Japan (Column 1, Table 3). From Table 4, it appears that many of the regions that lose (win) from the slowdown in China are net creditor (debtor) regions.[14] To explain these results, next, we turn to the analysis of the separate components of the welfare decomposition and compare our findings with those of Arndt *et al.* Because the terms of trade effects are similar in sign to those implied by Arndt *et al.*, we focus our discussion on the welfare components that differ across the two studies.

5.1 Financial Effects

The new effect, not captured in the earlier analysis of China's growth, is the financial effect (column 3, Table 3). We define it as the sum of the capital earnings and foreign inflows effects net of the foreign outflows effect: $\triangle EV_F = \triangle EV_{Y_K} + \triangle EV_{Y_A} - \triangle EV_{Y_F}$. The capital earnings effect, $\triangle EV_{Y_K}$ $(= EV^A_{Y_K} - EV^B_{Y_K})$, is the difference between the cumulative earnings effects due to capital accumulation in the alternative and base cases. The foreign inflows effect,

[13]The endowment effect encompasses only the non-capital factors of production.

[14]A region is a net debtor (creditor) if its income from equity it owns abroad is less (more) than its payments to foreign investors for equity they own in the region.

$\triangle EV_{Y_A}$ $(= EV^A_{Y_A} - EV^B_{Y_A})$, is the difference between the cumulative foreign inflows effects in the alternative and base cases. Finally, the foreign outflows effect, $\triangle EV_{Y_F}$ $(= EV^A_{Y_F} - EV^B_{Y_F})$, is the difference between the cumulative foreign outflows effect in the alternative and base cases. Table 4 shows the decomposition of the financial effect into its three components: the capital earnings, foreign inflows, and foreign outflows effects.

Results in the last two columns of Table 4 suggest a negative correlation between the net foreign income and the financial effect (EV_F). It implies a positive (negative) financial welfare effect for net-debtor (net-creditor) regions (excepting for Thailand). This is an outcome of lower rates of return to equity worldwide, which imply cheaper capital for investment-receiving regions and lower income from investments for investment-supplying regions.

As China's growth slows down, investment funds are diverted away from China and Hong Kong, and accumulate instead in other regions. With cumulative percentage changes in capital stocks in all non-China regions (except Hong Kong), higher in the alternative case than in the base case,[15] the capital earnings effect (Table 4) for all regions is positive (except for Taiwan and Hong Kong). For these two regions, the negative impact of the productivity shock in China translates into a substantial drop in the rates of return and capital stocks,[16] thereby lowering capital earnings relative to the base case by 2005.

If the model did not take account of foreign ownership of equity as in Arndt *et al.*, we would have associated the financial effect entirely with the capital earnings effect. This would have substantially overestimated the financial effect. However, the model adjusts the results to reflect the foreign ownership of assets. Column 2 of Table 4 displays the foreign inflows effect EV_{Y_A}. The negative sign of the foreign income effect is an outcome of lower

[15] Cumulative differences of the capital stock variable in 2005 are shown in column 1, Table 5.

[16] In Taiwan capital stocks remain unchanged.

world rate of return to equity (-1.1%) and lower foreign equity holdings. If a region is a large net creditor region and income from foreign investments declines, the foreign inflows effect is large and negative. Large net creditor regions (with positive net foreign income) such as Western Europe, Japan and Korea will experience the largest negative foreign inflows effects since their foreign income levels are high. For example, the losses due to the foreign inflows effect for the three largest net creditor regions: Western Europe, Japan and Korea, are US$ 7.9 billion, US$ 7.1 billion, and US$ 0.5 billion, respectively. For large net-creditor regions, this effect is larger than the capital earnings effect resulting in negative financial effects for these regions. The foreign inflows effect of the net-debtor and smaller net-creditor regions is comparatively small.

The foreign outflows effect is negative for almost all regions except for Taiwan and Hong Kong. This effect represents the payment each region has to make to foreign investors. As foreign investors rearrange their portfolios and shift investment away from China, Hong Kong, and Taiwan, the cumulative percentage changes in the stock holdings of all regions other than China, Hong Kong and Taiwan are positive. This implies higher income payments to foreign investors relative to the baseline despite cheaper foreign capital (*i.e.* the equity effect dominates the rate of return effect). The foreign outflows effect is much larger than the foreign inflows effect for all large net-debtor regions. For example, the United States and Canada have lost US$ 6.0 billion from an increase in their income payments to foreigners, but only US$ 2.3 billions from a decline in their foreign income inflows. We observe the opposite in the case of large net-creditor regions. In all regions, except the most closely related to China (Taiwan and Hong Kong), the foreign outflows effect reinforces the foreign inflows effect.

Overall, the financial effect is the largest effect in Western Europe, Japan and Latin

America. The big creditor regions, Western Europe and Japan, both lose around US$0.9 billion and US$1.4 billion from the slowdown in China primarily because of financial losses of around US$1.5 and US$2.4 billion, respectively. On the other hand, Latin America gains from the slowdown around US$1.1 billion despite the negative terms of trade effects because of the large positive financial effect (US$0.6 billion). In a number of regions, closely related to China, such as Hong Kong, Taiwan, and the Rest of the World, the terms of trade effect is the dominant one. The terms of trade effects in Korea and Taiwan are reinforced by large negative financial effects.

5.2 Other Welfare Effects

Since the technological progress and residual effects are small, we have omitted them from our discussion and instead spend the rest of the time looking at the non-accumulable and allocative efficiency effects. As shown on Table 3, these effects are also important contributors to aggregate welfare change in some regions.

The non-accumulable effect is positive for all regions except Hong Kong. As discussed in Arndt *et al.*, this effect would be negative for many regions in their study since a slowdown in China would affect negatively the endowment earnings of most regions. Their analysis, however, assumes that the capital endowment remains unchanged across the alternative and base case simulations. In this study, cumulative changes in the capital stocks of most regions are higher in the alternative simulation compared to the base case. As the cumulative change in the output of these economies increases relative to the base case, the level of earnings of all other endowments also increase due to the higher marginal productivity of non-capital factors in the alternative case relative to the baseline (see prices of all non-capital factors of production in the last three columns of Table 5). Thus, the non-accumulable endowment

effect is positive in all regions except Hong Kong.

The other factor which plays a role in determining the welfare outcome is the allocative efficiency effect. This effect is an outcome of the complex interaction between structural change in these economies in response to the slowdown in East Asia and the existing tax distortions. The two studies differ in their evaluation of the allocative efficiency effect. While the implied allocative efficiency effect of a slowdown in the study by Arndt *et al.* is negative in all regions but Hong Kong, the Philippines, and South Asia, in this study it is positive in all regions except for Korea and Malaysia (column five of Table 3). We explain these differences primarily with differences in the investment theory.

We illustrate this point by looking at the cases of the United States and Canada (USC), Western Europe (WEU), and Japan (JPN). The positive allocative efficiency effect for North America is determined mainly by large gains of about $US 664 million and $US 516 million attributable to taxes on intermediate use of services (row 10, column 4 of Table 8) and import taxes on transport, machinery and equipment products (last column, row 7 of Table 8), respectively. With the slowdown in China, investment increases in all rest of world regions relative to the base case and causes capital to accumulate at a higher rate as well. This increased abundance of capital stock is a boost to production activities in other regions (Table 9) including the United States and Canada. With the increase in domestic production, the use of domestically produced intermediate products increases. In those regions where taxes on the use of some intermediate domestic goods are high, increased use of domestic instead of imported intermediates leads to sizeable efficiency gains. For example, in the United States and Canada where taxes on services are highest (5.5% in Table 10), the increased use of domestic services leads to allocative efficiency gains of around $US 664 million compared to the base case.

The outflow of capital from China slows down its rate of industrialization, manifested in a 27% reduction in the share of 2005 GDP generated by the transport, machinery and equipment sector in China. This translates into a 60% drop in exports of these products from China and implies increased imports of transport, machinery and equipment into North America from regions other than China. This leads to substantial efficiency gains and to see why this is the case, we turn to Table 11. It shows that in 2005, the tariffs levied by the United States and Canada on China's imports of transport, machinery and equipment are much lower than those levied on any other region in the world except for Indonesia, Malaysia, the Philippines, and Thailand. Subsequently, an increase in imports from other regions leads to efficiency gains as these increases interact with large import tax distortions. The allocative efficiency effect for Western Europe is an outcome of the interaction of import tariff, intermediate tax and production tax distortions and investment driven expansion of the transport machinery and equipment and the utilities, housing and construction sectors (Table 12). Japan differs in that the second-best allocative efficiency gains are an outcome solely of production taxes interacting with investment-driven expansion of the transport, machinery and equipment, services and utilities, housing and construction sectors. Taxes levied on exports, destined to North America and Western Europe, also imply efficiency gains for Japan, as it increases its exports to these two regions relative to the base case (Table 13).

6 Conclusion

This paper revisits the topic of China's economic growth and its likely impact on the rest of the world, discussed previously by Arndt *et al.* (1997). Key limitations of this earlier study

are the projections methodology based on a comparative-static framework that does not take into account the important welfare implications of cross-ownership of assets and capital accumulation in other regions. To address these limitations, we use a dynamic model that preserves all features of the model used in the earlier study while introducing new investment theory and a modified income accounting framework. For comparison purposes, we employ the same data and experimental design for the baseline as in the earlier study.

The new dynamic model used in this study features adaptive expectations theory of investment, international capital mobility, cross-ownership of assets, and proper income accounting that takes into consideration net foreign capital income. We performed two simulations of the world economic growth between 1992-2005. The first one follows the World Bank's (now-dated) macroeconomic forecast for the period 1992-2005, while the second one incorporates a uniform productivity decline in China. The difference between the two isolates the impact of slower growth in China on its trading partners. We conduct a detailed explanation of the sources of welfare gains and losses, using a welfare decomposition modified to take into account foreign property ownership.

Several main points emerge from the comparison of our results with those in Arndt *et al.* In the event of a slowdown in China's economic growth, both studies imply a terms-of-trade loss in almost all non-China regions. However, other welfare determinants differ substantially between the two studies. In Arndt *et al.*, the endowment effect represents the effect of all endowments in the model including capital and does not take into account foreign ownership of capital. Our study, however, suggests a very different outcome. Instead of focusing on a single endowment effect, we separate capital from all other factors of production and study two effects: a financial effect related to capital and non-financial endowment effect related to all other endowments. The new investment theory in the model suggests that, with the

economic slowdown in China, investment, which would otherwise have gone to China, is now diverted to the rest-of-the-world regions as investors adjust their expectations about the region's growth in a downward direction. This implies lower rates of return worldwide, cheaper capital for net-debtor regions, and thus a positive (negative) financial effect for net debtor (creditor) regions.

Higher rates of investment in the rest of the world, also imply higher rates of capital accumulation and higher investment-driven domestic production relative to the baseline in regions other than China. With more capital located in these regions, the marginal productivity of all non-accumulable factors increases, leading to positive non-capital endowment effects for the rest of the world economies and allocative efficiency gains in economies with tax distortions in the markets for domestic intermediates. Furthermore, the low tariffs on Chinese imports of transport, machinery and equipment products and the shift away from China in the sourcing of these imports, imply efficiency gains for regions with high tariffs on imports of these manufacturing products from regions other than China. Thus, unlike Arndt *et al.*, we conclude that net debtor regions such as North America, Latin America and Sub-Saharan Africa are all likely to benefit from slower growth in China. The main reasons for our findings are the positive financial, allocative efficiency and non-capital endowment effects. We trace these to the new investment theory of adaptive expectations, along with international capital mobility and cross-ownership of financial assets, which are central innovations in this study.

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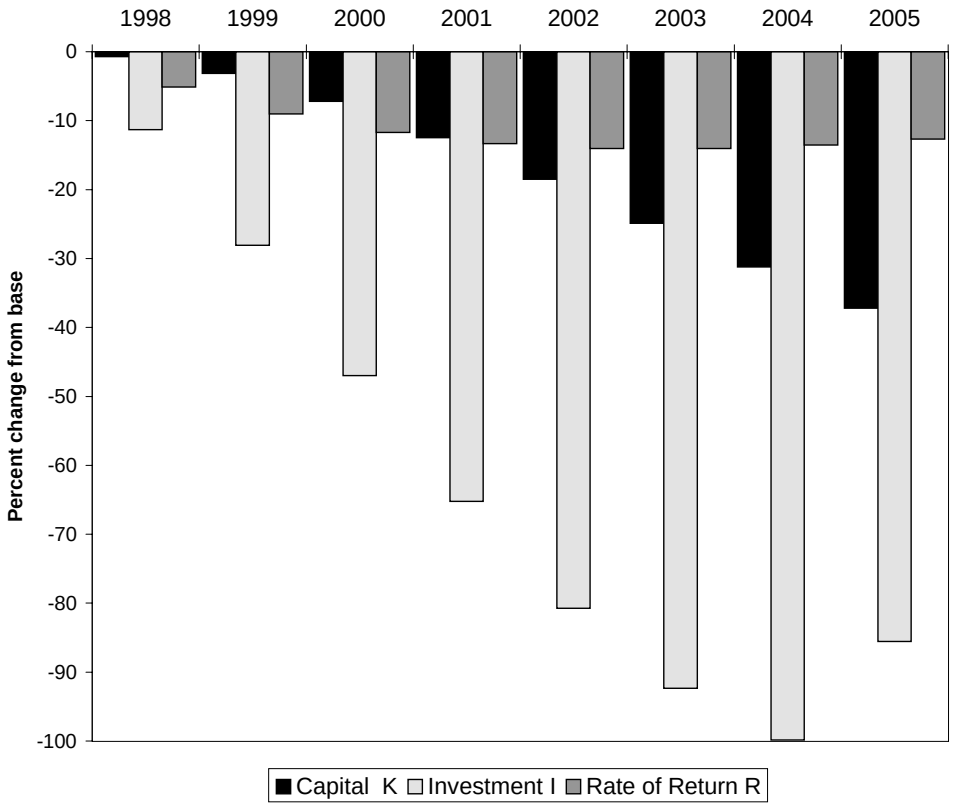

Figure 1: Selected Variables for China: Cumulative Differences

Table 1: Projection Scenario, Selected Variables (Annual Average Percentage Changes)

Region	Population	Labor Force	Human Capital	A[17]	B[18]	Real GDP[19]
USA and Canada (USC)	0.9	1.0	5.1	-0.3	-0.4	2.6
Western Europe (WEU)	0.2	0.1	9.3	-0.4	1.6	2.4
Japan (JPN)	0.2	-0.2	4.7	0.9	1.6	2.8
Korea (KOR)	0.8	0.9	6.2	3.2	-0.9	6.7
Taiwan (TWN)	0.8	1.3	6.2	2.7	-0.9	6.1
Hong Kong (HKG)	0.5	0.6	4.8	-0.3	3.2	5.6
China (CHN)	0.9	1.2	3.5	6.4	-2.6	9.2
Indonesia (IDN)	1.4	2.1	9.9	2.6	-8.2	6.3
Malaysia (MYS)	1.9	2.7	10.3	1.1	-3.9	8.0
Philippines (PHL)	2.2	2.6	5.8	-0.1	-2.8	4.5
Thailand (THA)	1.3	1.8	7.3	0.8	-6.2	7.9
Latin America (LTN)	1.5	2.2	6.4	0.5	-3.8	3.6
Sub-Saharan Africa (SSA)	2.8	3.1	7.2	1.2	-4.6	3.4
South Asia (SAS)	1.8	2.3	5.8	2.5	-2.9	5.2
Rest of World (ROW)	1.4	1.7	7.7	-1.2	0.7	2.6

[17]Variable A represents factor saving technological change, all factors except physical capital.

[18]Variable B stands for technological bias towards capital.

[19]Numbers, derived from the baseline simulation, represent average annual growth rates.

Table 2: Changes in Selected Variables for the Chinese Economy, Base Simulation: 1992-2005 (Volumes in 1992 $US Millions)

Commodity	% Chg. In Share	Change in Exports		Change in Imports	
Classes[20]	Value Added	%	volume	%	volume
Primary Agriculture (PAgr)	-18.9	515	28017	86	2727
Processed Food (PFood)	-16.7	96	5732	214	5767
Natural Resources (NRes)	7.0	362	25680	132	7155
Textiles (Text)	-1.0	107	8101	201	19297
Wearing Apparel (WApp)	-0.3	173	28596	67	510
Light Manufactures (LMnfc)	28.9	323	69820	197	17474
Transportation, Machinery & Equipment (TM&Eq)	55.3	456	71302	127	45662
Heavy Manufactures (HMnfc)	37.8	380	28904	180	37672
Utilities, Housing & Construction (UH&CS)	-20.5	53	1	279	791
Other Services (Svces)	13.7	290	37596	112	6305
Investment Goods (CGDS)	-34.2	NA	NA	NA	NA

[20]Primary Agriculture: paddy rice, wheat, grains (other than wheat and rice), non-grain crops, wool, and other livestock products; Processed Food: fisheries, processed rice, meat products, milk products, other food products, beverages and tobacco; Natural Resources: forestry, coal, oil, gas, other minerals, petroleum and coal products, non metallic, minerals; Textiles: textiles; Wearing Apparel: wearing apparel; Light Manufactures: leather industries, lumber and products, pulp, paper, etc., fabricated metal products and other manufacturing; Transportation, Machinery & Equipment: transport industries machinery and equipment; Heavy Manufactures: chemicals, rubber and plastic, primary ferrous metals, nonferrous metals; Utilities, Housing & Construction: electricity, gas, and water, construction ownership of dwellings; Other Services: trade and transport, other services (private and government).

Table 3: Comparative Differences: Alternative - Base Case in 2005 in 1992 $US Millions

Region	% Change in Welfare (u)	Aggregate Welfare Effect (EV)	Terms of Trade Effect	Financial Effect	Alloca-tive Effect	Nonaccu-mulable Endowment Effect	Technical Progress Effect	Residual Effect
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United States & Canada	0.04	2526	-606	1196	1597	384	-33	-13
Western Europe	-0.01	-873	-211	-1468	591	241	-55	29
Japan	-0.04	-1420	-223	-2383	740	207	186	53
Korea	-0.08	-242	-45	-106	-243	29	70	53
Taiwan	-0.16	-328	-346	-53	24	10	13	25
Hong Kong	-1.60	-1066	-2140	960	124	-18	3	5
Indonesia	-0.04	-49	-124	-10	30	30	11	14
Malaysia	-0.24	-144	-69	-25	-83	19	3	11
Philippines	0.20	98	4	21	68	6	0	-1
Thailand	0.24	249	60	14	155	18	4	-3
Latin America	0.11	1184	-165	646	512	175	18	-35
Sub-Saharan Africa	0.02	60	-170	95	58	60	16	2
South Asia	0.11	330	50	27	182	34	31	5
Rest of World	-0.05	-879	-2188	598	324	397	-18	8

Table 4: Financial Decomposition: Cumulative Differences in 2005, 1992 $US Millions

Region	Capital Earnings Effect $\triangle EV_{Y_K}$	Foreign Inflows Effect $\triangle EV_{Y_A}$	-(Foreign Outflows Effect) $\triangle EV_{Y_F}$	Financial Effect $\triangle EV_F$	Net Foreign Income (Base)
United States & Canada	9540	-2332	-6012	1196	-233519
Western Europe	12188	-7980	-5676	-1468	37671
Japan	6040	-7125	-1299	-2383	425076
Korea	410	-460	-55	-106	19280
Taiwan	-27	-103	77	-53	13173
Hong Kong	-309	-2	1271	960	-34463
Indonesia	173	-172	-11	-10	12095
Malaysia	58	-78	-6	-25	8389
Philippines	110	-35	-54	21	-2917
Thailand	292	-148	-131	14	1886
Latin America	1893	-43	-1204	646	-116881
Sub-Saharan Africa	301	-32	-175	95	-18042
South Asia	319	-16	-277	27	-8881
Rest of World	3011	-544	-1870	598	-122875

Table 5: Selected Variables: Cumulative Percentage Changes from Base Case in 2005

	K	Y_A	Y_F	Price of	
				Labor	Human Capital
United States & Canada	0.70	-3.2	2.3	0.3	0.3
Western Europe	0.68	-1.3	0.9	0.3	0.2
Japan	0.68	-1.9	1.7	0.4	0.3
Korea	0.61	-3.8	3.2	0.2	0.1
Taiwan	0.04	-1.1	-1.0	-0.5	-0.4
Hong Kong	-0.52	-0.7	-4.6	-2.5	-2.8
Indonesia	0.81	-2.7	2.8	0.6	0.2
Malaysia	0.46	-1.6	0.4	0.2	0.1
Philippines	0.85	-2.3	1.5	0.5	0.4
Thailand	1.00	-4.3	4.3	1.0	0.6
Latin America	0.62	-2.4	1.3	0.5	0.3
Sub-Saharan Africa	0.58	-2.4	1.2	0.4	0.2
South Asia	0.62	-5.3	4.6	0.5	0.4
Rest of World	0.62	-2.8	1.6	0.3	0.2

A Supplementary Tables

Table 6: Changes in the Volume of Chinese Bilateral Exports, by Destination in 1992 $US Millions, Base Simulation: 1992-2005

Region	PAgr	PFood	NRes	Text	WApp	LMnfc	TM&Eq	HMnfc
USC	267	242	2818	329	1574	19060	11577	2729
WEU	622	1021	1875	552	1558	27708	13106	5987
JPN	1281	459	6086	1135	15573	5473	3828	3369
KOR	9592	-45	3967	943	326	1595	1566	2956
TWN	211	212	766	156	381	1059	2453	942
HKG	299	266	2195	591	2166	2601	21856	4219
IDN	1164	21	240	71	38	251	431	676
MYS	7772	248	316	138	37	610	1476	587
PHL	-13	5	265	120	30	214	447	138
THA	3990	1483	1016	382	115	647	1212	2039
LTN	118	46	358	188	254	1073	1540	354
SSA	98	112	196	552	201	1005	1621	344
SAS	127	-3	369	191	10	251	968	546
ROW	2490	1665	5213	2750	6334	8271	9218	4017

Table 7: Changes in the Volume of Chinese Bilateral Imports, by Source in 1992 $US Millions, Base Simulation: 1992-2005

Region	PAgr	PFood	NRes	Text	WApp	LMnfc	TM&Eq	HMnfc
USC	1478	329	1387	296	-2	1229	10242	6106
WEU	-384	-127	474	-225	-86	-201	4246	1122
JPN	195	235	2231	928	-32	734	5249	4722
KOR	437	246	214	6999	61	1879	2878	6998
TWN	67	42	105	5845	26	2950	5860	6197
HKG	12	936	34	2424	391	5754	10306	3295
IDN	-15	39	477	646	24	3248	145	577
MYS	108	2128	62	80	2	136	826	503
PHL	112	238	3	50	10	10	93	260
THA	-76	324	-8	841	69	648	1171	341
LTN	44	987	198	513	3	512	187	2428
SSA	228	112	106	21	10	38	133	193
SAS	179	78	182	615	21	177	127	244
ROW	343	199	1688	262	12	362	4199	4685

Table 8: Allocative Efficiency Effects for North America: Comparative Dynamic Results in 1992 $ US Millions in 2005

	Total	Output Tax	Intermediates Tax		Consumption Tax				Export Tax	Import Tax
			Imported	Domestic	Private		Government			
					Imported	Domestic	Imported	Domestic		
PAgr	-76	-89	0	9	0	0	0	0	5	-2
PFood	-2	-7	-1	5	-3	4	0	0	-3	4
NRes	86	-9	26	5	4	11	1	2	0	46
Text	3	0	0	3	-0	0	0	0	0	1
WApp	0	0	0	0	-0	0	0	0	0	0
LMnfc	-84	4	-4	56	-2	3	0	0	0	-142
TM&Eq	641	-3	30	97	1	0	0	0	0	516
HMnfc	-26	-2	1	20	0	1	0	0	1	-47
UH&CS	379	130	0	129	0	116	0	4	0	0
Svces	677	7	0	664	-10	17	-1	0	0	0
Total	1598	32	52	988	-11	151	0	7	2	375

Table 9: Output Quantities: Cumulative Percentage Changes from Base Line in 2005

	USC	WEU	JPN	KOR	TWN	HKG	CHN	IDN	MYS	PHL	THA	LTN	SSA	SAS	ROW
PAgr	0.3	0.2	0.3	0.5	0.4	1.8	-26.7	0.0	0.3	0.0	0.0	0.1	0.1	0.1	0.3
PFood	0.2	0.1	0.0	-0.6	0.5	10.8	-32.4	-0.1	-2.2	0.3	-1.1	-0.0	0.2	0.1	0.2
NRes	-0.5	-0.2	-1.0	-0.5	-0.2	-1.8	-40.7	-0.4	-0.2	-0.3	-0.1	-0.2	-0.2	-0.4	-0.4
Text	0.1	-0.0	0.2	-3.3	-6.1	0.6	-34.7	2.8	-0.7	0.2	0.3	0.1	0.5	-0.2	0.8
WApp	0.2	-0.0	3.0	5.3	2.1	5.0	-26.3	7.9	1.0	1.8	3.8	0.6	0.7	0.9	1.9
LMnfc	0.7	0.6	0.6	1.2	1.9	-0.1	-37.1	-0.3	2.3	2.1	1.6	0.7	0.9	0.7	1.2
TM&Eq	0.3	0.4	0.7	1.8	0.6	-6.0	-56.4	0.7	2.6	1.0	0.3	1.0	1.0	1.2	0.7
HMnfc	-0.1	-0.1	0.0	-1.0	-1.7	-18.0	-45.3	-0.2	-1.5	-1.1	-1.0	-0.0	0.3	0.3	-0.0
UH&CS	0.9	1.1	1.1	0.7	-0.1	-6.6	-83.0	1.7	0.1	1.3	2.1	1.5	0.8	0.7	1.0
Svces	0.1	-0.0	0.1	0.2	0.2	2.0	-39.9	0.1	0.2	0.2	0.4	0.2	0.1	0.1	0.1
Cgds	2.2	2.0	1.8	1.3	0.0	-7.6	-85.6	11.1	0.1	2.5	4.5	2.8	2.2	1.9	1.8

Table 10: Tax Equivalents on Domestic Intermediates Usage in North America, % Change in 2005

	PAgr	PFood	NRes	Text	WApp	LMnfc	TM&Eq	HMnfc	UH&CS	Svces	CGDS	All Sectors
PAgr	2.6	1.6	2.2	2.1	1.1	1.4	1.1	2.2	5.1	1.2	0.0	2.0
PFood	0.3	0.9	2.0	9.3	6.2	2.0	11.0	1.2	25.0	3.2	0.0	1.9
NRes	4.7	1.9	3.3	3.4	2.7	1.9	2.4	4.0	4.5	6.1	-1.4	3.9
Text	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.5	2.9	0.8	0.9	0.7
WApp	0.0	0.2	0.2	0.5	0.3	0.3	0.2	0.4	0.2	0.7	0.0	0.4
LMnfc	0.9	0.8	1.2	0.9	0.6	1.5	1.2	1.1	2.2	1.2	0.8	1.4
TM&Eq	1.0	1.1	1.2	0.7	0.9	1.1	1.1	1.1	1.6	1.1	1.5	1.3
HMnfc	1.7	1.5	1.7	1.7	1.6	1.3	1.5	1.8	2.0	1.5	4.3	1.6
UH&CS	3.1	4.2	3.8	4.6	4.4	3.8	3.6	4.3	2.5	2.7	0.6	1.6
Svces	6.6	5.3	6.3	5.7	5.6	5.3	5.9	5.0	6.5	4.8	10.8	5.5

Table 11: Import Tariff Equivalents by Commodity in North America, % Change in 2005

	USC	WEU	JPN	KOR	TWN	HKG	CHN	IDN	MYS	PHL	THA	LTN	SSA	SAS	ROW
PAgr	20	26	27	34	25	36	24	39	39	35	36	44	39	42	22
PFood	5	10	1	2	2	4	1	2	1	2	3	5	6	3	8
NRes	0	2	8	5	6	2	3	1	1	3	2	1	1	1	1
Text	2	7	11	12	8	8	11	11	12	7	9	7	6	6	9
WApp	-0	14	10	20	21	27	17	21	18	17	19	18	17	17	18
LMnfc	0	4	2	7	4	4	7	6	1	5	5	6	2	5	3
TM&Eq	1	8	22	6	10	2	2	1	1	1	2	3	5	8	5
HMnfc	1	7	21	9	4	4	17	4	2	4	6	6	6	8	5
UH&CSs	0	0	-0	0	-0	0	0	0	0	0	0	0	0	0	0
Svces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 12: Allocative Efficiency Effects for Western Europe: Comparative Dynamic Results in 1992 $US Millions in 2005

	Total	Output Tax	Intermediates Tax		Consumption Tax				Export Tax	Import Tax
			Imported	Domestic	Private		Government			
					Imported	Domestic	Imported	Domestic		
PAgr	-300	-177	0	-12	-4	1	0	0	-42	-66
PFood	-75	5	0	2	-76	22	0	0	-10	-19
NRes	-121	-69	40	-95	18	11	1	0	-84	57
Text	-3	0	0	0	1	-6	0	0	0	2
WApp	3	0	0	0	2	-5	0	0	0	6
LMnfc	-20	49	2	27	-55	32	-3	0	-2	-71
TM&Eq	559	50	66	99	22	-47	0	0	-17	386
HMnfc	8	-8	4	6	4	-3	1	0	-2	6
UH&CS	543	269	0	263	0	11	0	0	0	0
Svces	-2	-12	-2	119	-9	-44	0	-3	-51	0
Total	592	107	109	410	-97	-26	-2	-3	-201	303

Table 13: Allocative Efficiency Effects for Japan: Comparative Dynamic Results in 1992 $US Millions in 2005

	Total	Output Tax	Intermediates Tax		Consumption Tax				Export Tax	Import Tax
			Imported	Domestic	Private		Government			
					Imported	Domestic	Imported	Domestic		
PAgr	-92	55	0	0	0	0	0	0	0	-38
PFood	136	16	0	0	0	0	0	0	0	120
NRes	-97	-152	0	0	0	0	0	0	0	55
Text	-2	0	0	0	0	0	0	0	0	-3
WApp	-115	26	0	0	0	0	0	0	0	-142
LMnfc	57	58	0	0	0	0	0	0	11	-12
TM&Eq	417	193	0	0	0	0	0	0	220	4
HMnfc	-17	-21	0	0	0	0	0	0	8	-3
UH&CS	314	314	0	0	0	0	0	0	0	0
Svces	141	141	0	0	0	0	0	0	0	0
Total	740	520	0	0	0	0	0	0	239	-18