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Does it Matter Whether Market Distortions are Evaluated Using Comparative-Statics or Dynamics?

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Abstract

We analyse the welfare outcomes of market distortions using a general-equilibrium model of a small, open economy that captures the trade-theoretic continuum from specific factors to Heckscher-Ohlin. We show the importance of two intrinsically dynamic phenomena on evaluating market distortions: structural change and imperfect factor mobility. We find that when these phenomena are captured in a dynamic framework, market distortions can generate welfare effects that contradict those generated by a comparative-static framework. We also find that the degree of factor mobility is important for accurately estimating the size of welfare effects. Our results suggest that market distortions should be evaluated in a dynamic framework that represents structural change and imperfect factor mobility, and that the degree of factor mobility should be treated as a parameter whose value is uncertain and subjected to sensitivity analysis.

JEL codes: C61, D58, D61, F13

Keywords: market distortions, welfare, comparative-statics versus dynamics, general equilibrium.

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1. Introduction

It is well established in trade theory that in the standard 2×2 (two good, two factors of production) models of small, open economies (e.g., specific factors, Heckscher-Ohlin), free trade is welfare maximising (Johnson (1960); Corden (1974); Vousden (1990); Krugman and Obstfeld (2003)). A similar result holds for simple two-good exchange models; the optimal tax rate on any good is zero. These conclusions are confirmed within comparative-static partial- and general-equilibrium frameworks. But do these results hold in the presence of two phenomena that are commonly observed in most economies: (i) ongoing structural change; (ii) imperfect factor mobility?

Structural change is a well-documented empirical phenomenon; see da Silva and Teixeira (2006) for the seminal survey of the economics literature on structural change.[1] Such change can take many forms. This includes (but is not limited to): a changing composition of production techniques over time; a changing composition of primary factors in production over time; a changing composition of output and investment over time; and a changing composition of spending patterns over time. These forms of structural change have been variously attributed to: biased and Hicks-neutral technological change; changes in relative factor endowments; differential rates of technological change across sectors; and rising per-capita incomes and their interaction with differential income elasticities across commodities. The common theme in these forms of structural change is a "changing composition...over time". Thus, structural change is an intrinsically dynamic concept.

Imperfect factor mobility is also a well-documented empirical phenomenon. For the EU (European Union), a group of nations with a greater than average degree of economic integration, imperfect factor mobility manifests itself in large and persistent regional disparities in rates of

[1] The following discussion of the nature and causes of structural change is largely drawn from da Silva and Teixeira (2006) and relies on the survey of the literature on structural change contained therein.

participation, unemployment, and employment creation. Further, large disparities in incomes also persist across Union members. Possible causes of less-than-perfect factor mobility for economically integrated groups of nations, such as the EU, include: language and cultural barriers; regulatory barriers to integrated factor markets; transportation, information and other costs; and illiberal migration policies (Begg 1995; Wildasin 2000).

Less-than-perfect interregional factor mobility has also been identified within nation-states. For the US (United States), interregional factor mobility improved over the course of the 20th century consistent with improvements in transportation and communication. Interindustry factor mobility varied considerably in the US over the 19th and 20th centuries: mobility increased sharply during 19th century due to improvements in transportation and the introduction of factory production; mobility declined during the 20th century due to the greater reliance on specialised equipment and knowledge (Hiscox 2002). With regard to other countries, interindustry factor mobility in Great Britain, France, Sweden, Canada and Australia exhibited marked cross-national differences over the 19th and 20th centuries; but it also exhibited historical trends broadly similar to those identified by Hiscox (2002) for the US, and for the same reasons (Hiscox 2001). As with the EU, imperfect interregional and interindustry factor mobility manifests itself through persistent differentials in factor returns and utilisation, i.e., over time. Thus, like structural change, imperfect factor mobility is an intrinsically dynamic concept.

Given that both structural change and imperfect factor mobility are dynamic concepts, understanding their importance on the welfare-maximising outcome for market distortions requires their evaluation within an explicitly dynamic framework. While comparative-statics can provide equilibrium solutions before and after any displacement of equilibrium, it provides no information on the time path between solutions. Further, it cannot represent, in a meaningful sense, the way that economic systems evolve over time, e.g., ongoing structural change, the gradual movement of factors across activities. Our interest here is to properly evaluate such dynamic concepts and their effect on the welfare-maximising outcome for market distortions; thus we apply a dynamic framework. We adopt the simplest form of dynamics one can imagine; a recursively-dynamic discrete-time framework with no changes in stocks and where agents hold adaptive expectations.[2] This allows for a minimum point of departure from comparative-statics, which allows for transparency in comparing the effects of comparative-statics and dynamics.[3]

In testing the welfare-maximising outcome for market distortions, we apply a general-equilibrium model with only one type of agent, producers, who are competitive and efficient, i.e., they are price-takers and they earn no pure profits. Domestic prices are set internationally so that the economy is both small and open. With the appropriate choice of parameter values, the degree of factor mobility is varied so that the model captures the extremes of specific factors and Hecksher-Ohlin, as well as degrees of mobility in between. We initially generate the standard result for market distortions imposed in a small, open economy, within a specific factors and Hecksher-Ohlin framework and also an in-between framework. We then allow for structural change and varying degrees of factor mobility within a dynamic framework, and test the importance of the two dynamic phenomena on the welfare-maximising outcome. Lastly we compute comparative-dynamic results with different forms of structural change and factor mobility, and compare welfare outcomes for a given market distortion.

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[2] By recursively-dynamic we refer to multi-period models in which results are computed one period at a time. This is to be contrasted with fully intertemporal models, in which results are computed simultaneously for all periods. For a discussion on recursive versus intertemporal models see Malakellis (2000), p. 3.

[3] Previous work in this area models dynamics using a much richer theoretical treatment than that adopted here, e.g., the inclusion of investment that is explicitly linked to endogenous physical capital formation, rational expectations by agents, overlapping generations with endogenous saving rates, etc. See Baxter (1992) for an example of a dynamic Hecksher-Ohlin model; see Eaton (1987) for an example of a dynamic specific-factors model.

2. A stylised general-equilibrium model

2.1 Theory, data and closure

Our model depicts the supply side of a small, open economy with two industries (i = 1, 2) and two factors of production – labour (L_i) and capital (K_i). The return to labour is in the form of an economywide wage (W), whereas rentals to capital (Q_i) can be sector specific. Both industries are competitive and so take W and Q_i as given; they also take their output price (P_i) as given. Output (X_i) technology is characterised by a Cobb-Douglas function with homogeneity of degree one in L and K. Both producers are efficient and so aim to maximise profits (π),

$$\pi = P_i X_i - WL_i - Q_i K_i. \qquad (1)$$

The producers' problem is to choose output X_i subject to

$$X_1 = K_1^{\alpha} L_1^{1-\alpha}, \ (\alpha = 0.2) \qquad (2)$$

$$X_2 = K_2^{\beta} L_2^{1-\beta}, \ (\beta = 0.8). \qquad (3)$$

As the capital technology parameters α and β are set at <1, the model is characterised by diminishing returns in each factor separately. Nevertheless, the production functions exhibit constant returns to scale in both factors together as the capital and labour technology exponents sum to one for each producer. With $\alpha \neq \beta$, different production technologies are employed in each sector such that good 1 is labour intensive and good 2 is capital intensive. This also results in a non-linear production possibilities frontier (PPF).

Substituting (2) into (1), finding the first-order condition with respect to L_1 and rearranging gives the optimal L_1 for profit maximisation:

$$L_1 = (1-\alpha)^{1/\alpha}(P_1/W)^{1/\alpha}K_1. \qquad (4)$$

Together with the production function, (4) determines both L_1 and K_1. It implies

$$K_1/L_1 = (1-\alpha)^{-1/\alpha}(W/P_1)^{1/\alpha}. \qquad (5)$$

Linearising (5) gives

$$k_1 - l_1 = (1/\alpha)\,(w - p_1),$$

where lower-case symbols are the percentage change equivalents of upper-case symbols. Thus, the capital-labour ratio is a positive function of W/P_1 adjusted by the inverse of the industry's capital-output ratio $(1/\alpha)$.[4]

Via symmetry, the capital-labour ratio for industry 2 will equal

$$K_2/L_2 = (1-\beta)^{-1/\beta}(W/P_2)^{1/\beta}. \tag{6}$$

Although rental rates do not enter (5) and (6), the assumption of zero pure profits provides the necessary link between capital usage and the cost of capital:

$$P_iX_i = WL_i + Q_iK_i,\ \ (i = 1, 2). \tag{7}$$

If W/P_i (i = 1, 2) rises due to a rise in W, both firms will attempt to substitute capital for labour. This will in turn will drive up Q_i (i = 1, 2) and therefore P_i (i = 1, 2); but the rise in P_i (i = 1, 2) will be less than the rise in Q_i (i = 1, 2).[5] And the rise in P_2 will be greater than the rise in P_1 as $K_2/X_2 > K_1/X_1$. The increase in P_i (i = 1, 2) will moderate the rise in W/P_i (i = 1, 2) and both firms will moderate their substitution of capital for labour, but the moderation will greater for the capital-intensive industry (i = 2).

We allow for varying degrees of capital mobility between industries by imposing the reduced-form arbitrage condition

$$K_1/K_2 = \mathrm{A}(Q_1/Q_2)^{\theta}, \tag{8}$$

[4] Normally we would use the first-order condition for L_1 to solve for K_1, and then insert the resulting expression for K_1 into the first-order condition for K_1, and then solve for the optimal L_1. But as we are assuming constant returns to scale in both factors together $(1-\alpha + \alpha = 1)$, such a strategy will yield no expression for the optimal L_1. This problem is avoidable if we were solve the producer's problem as one of constrained maximisation. Solving the producer's problem as an unconstrained maximisation problem allows us to generate expressions explaining the capital-labour ratio directly without further manipulation of the demand functions for capital and labour. When we assume capital is perfectly immobile (Section 3), the linearised version of (5) is consistent with equation (3P-19) in Krugman and Obstfeld (2003), p. 711, which is derived to explain the properties of the specific-factors model. Note that when Krugman and Obstfeld (2003) derive expressions to explain the properties of the Hecksher-Ohlin model (p. 714–16), they obtain no expressions explaining the optimal labour and capital, but instead generate expressions explaining the optimal outputs for each industry (4P-12) and (4P-13).

[5] Here we are assuming that $Q_1 = Q_2$, so that capital is perfectly mobile between industries.

where θ is a parameter that controls the degree to which capital moves between industries, and A is a positive parameter.[6] Where $\theta = \infty$, capital is perfectly mobile between industries and $Q_1/Q_2 = 1$; here the model approximates the Hecksher-Ohlin model. For $\theta = 0$, capital is completely sector specific and immobile between industries; this approximates the specific-factors model.[7] For $0 > \theta > \infty$, capital is imperfectly mobile and intersectoral movements of capital are related to rentals in a way that sees capital move to the more profitable industry. For all values of θ the PPF will be non-linear and quasi-concave. For smaller values of θ, the PPF will exhibit sharper curvature reflecting higher opportunity cost of good 1 in terms of good 2 at every allocation of factors; we discuss this further below.

Aggregate capital and labour are fixed and fully utilised. Total capital (K) and labour (L) are defined as

$$K = K_1 + K_2, \tag{9}$$

$$L = L_1 + L_2. \tag{10}$$

Domestic prices (P_i) are based on world prices (PI_i), indirect taxes (T_i) and the nominal exchange rate (E);

$$P_i = EPI_iT_i, \; (i = 1, 2). \tag{11}$$

Indirect taxes are *ad valorem* and T_i represents the power of the tax $(1 + t_i)$, where t_i is the tax rate on good i. All variables determining P_i are exogenous: E is the numeraire; PI_i is assumed to be independent of decisions in the domestic economy; T_i is a policy instrument. With a fixed

[6] Equation (8) is a reduced form of a more complex arbitrage condition that would explicitly account for barriers to capital mobility discussed in Section 1 (e.g., reliance on specialised equipment and knowledge). But our interest here is in the welfare effects of factor mobility on market distortions in the presence of structural change, rather than the reasons for factor immobility. Thus, we do not complicate the analysis with more structure than necessary.

[7] The specific-factors model is specified with three factors (land, labour and capital) and two goods (Jones 1971, Samuelson 1971). Labour is perfectly mobile and used by both sectors (as it is here), whereas capital and land are specific to different sectors. Thus, setting $\theta = 0$ here makes capital specific to each sector and assigns industry 2 as the industry intensive in the use of the specific factor. So here capital plays the twin role of capital and land in the specific-factors model.

international price ratio (PI_1/PI_2), any non-unitary value for T_i will only distort domestic production decisions and will have no terms of trade implications for this economy. So whilst it is assumed that both goods are tradable and that producers are price-takers, no explicit assumption is made in regard to a specific import-competing industry, or export industry; given our assumption of fixed PI_i, this is not necessary. Consequently, $T_i > 1$ will have the same effects as an export subsidy or an import tariff in a model with endogenous international terms of trade, i.e., it will raise the domestic price of good *i* and encourage resources to move to industry *i*.

To avoid complicating the analysis with more structure than necessary, there is no utility function or demand side in the model. Consequently, in contemplating welfare issues we apply revealed preference and examine consumption possibilities. Consumption possibilities are maximised when firms maximise the value of output measured in world prices relative to the initial equilibrium. Thus welfare (U) is defined as follows,

$$U = \frac{\left(PI_1 X_1 + PI_2 X_2\right)}{\left(PI_1 \bar{X}_1 + PI_2 \bar{X}_2\right)}, \tag{12}$$

where the $\bar{X}$s are the initial levels of output of each commodity.[8] The numerator in (12) measures income (or output) at world prices; the denominator measures initial income at world prices and its inclusion prevents welfare effects resulting purely from price changes with no accompanying reallocation of resources. This is obvious if we raise or lower one of the prices PI_i but do not allow outputs to change; welfare will remain unchanged. Thus, PI_1/PI_2 should not be interpreted here as the international terms of trade in the normal sense; that is, where an

[8] Note that equation (12) does not include revenue raised (paid) by a positive (negative) tax. With no demand side, any such revenue is returned in the form a lump-sum payment. This is easily shown by reference to equation (7), which forces the value of output in domestic prices $\left(\sum_i P_i X_i\right)$ to equal total factor payments in the economy $\left(\sum_i WL_i + \sum_i Q_i K_i\right)$. This can be reinterpreted as equality between total income of producers and total expenditure by factor owners. Thus, there is no gap between income and expenditure as would be normally represented by government revenue.

improvement (deterioration) increases (reduces) welfare even with no change in output. In contrast, equation (12) captures any change in X_1/X_2 with no corresponding change PI_1/PI_2, say, due to an import tariff, as a decrement in welfare.[9]

The model contains (7i + 5) variables in (4i + 4) equations; the equations are (2)–(3), (5)–(12). To close the model, we need (3i + 1) variables set as exogenous; these are E, PI_i, T_i, K and L. Following the normalisation convention established by Harberger (1962), we set the initial values of all prices to one. The powers of both taxes are also set to one indicating zero tax rates in the initial equilibrium. To avoid spurious welfare effects in model solutions, the initial solution is chosen so as to ensure the model begins in equilibrium. With equal or zero tax rates and equal world prices (and hence equal domestic prices), the economy begins in equilibrium and operates at the point where the value of total output ($P_1X_1 + P_2X_2$) is maximised. Given the other parameters in the model, the optimal initial values of X_i are 0.6063. All simulations start from this initial equilibrium.

2.2 Comparative-static and recursively-dynamic solutions

The model represented by equations (2)–(3), (5)–(12) specifies behavioural and definitional relationships. There are m (= 4i + 4) such relationships involving a total of p (= 7i + 5) variables. Of the p variables, e (= 3i + 1) are exogenous. The e variables can be used to shock the model to simulate changes in the m (= p – e) endogenous variables. The system can be compactly written in matrix form as

$$\mathrm{F}(\mathbf{N}, \mathbf{X}) = \mathbf{0}, \qquad (13)$$

[9] An alternative modelling strategy would be to add a demand side to the model, in which case we explicitly assume which good is imported and which is exported. In such a framework, exogenous changes in PI_1/PI_2 would generate terms of trade effects.

where F represents a $m \times p$ matrix of differentiable functions, $\mathbf{N}$ is a vector of endogenous variables, $\mathbf{X}$ is a vector of endogenous variables, and $\mathbf{0}$ is the $p \times 1$ null vector. Assume that the system represented by (13) has a solution in the neighbourhood of the values described in Section 2.2. We call this the initial solution and represent it by the vectors ($\mathbf{N}^{\mathrm{I}}$, $\mathbf{X}^{\mathrm{I}}$). If we perturb the model by choosing new values for some of the exogenous variables, represented by $\mathbf{X}^{\mathrm{F}}$, we have a new solution represented by

$$\mathrm{F}(\mathbf{N}^{\mathrm{F}}, \mathbf{X}^{\mathrm{F}}) = \mathbf{0}. \tag{14}$$

The system represented by (14) is the comparative-static solution to our model. In moving from the initial solution (13) to the final (or new) solution (14), we calculate

$$\Delta\mathbf{N} = \mathrm{F}(\mathbf{N}^{\mathrm{F}}, \mathbf{X}^{\mathrm{F}}) - \mathrm{F}(\mathbf{N}^{\mathrm{I}}, \mathbf{X}^{\mathrm{I}}), \tag{15}$$

which tells us the effects on the endogenous variables.

Imagine we now wish to calculate a series of recursively-dynamic solutions. Working with (15), we rewrite it as

$$\Delta\mathbf{N}_{\mathrm{t}} = \mathrm{F}(\mathbf{N}^{\mathrm{F}}_{\mathrm{t}}, \mathbf{X}^{\mathrm{F}}_{\mathrm{t}}) - \mathrm{F}(\mathbf{N}^{\mathrm{I}}_{\mathrm{t}}, \mathbf{X}^{\mathrm{I}}_{\mathrm{t}}),\ \ \mathrm{t} = 0. \tag{16}$$

Equations (16) represent the same solution as (15), except they are for the first period of a T period solution calculation. For t = 1 (the second period of a T period solution), we set $\mathbf{N}^{\mathrm{I}}_{\mathrm{t=1}} = \mathbf{N}^{\mathrm{F}}_{\mathrm{t=0}}$ and $\mathbf{X}^{\mathrm{I}}_{\mathrm{t=1}} = \mathbf{X}^{\mathrm{F}}_{\mathrm{t=0}}$. That is, we use the final solution for t = 0 as the initial solution for t = 1. We then calculate $\Delta\mathbf{N}_{\mathrm{t}}$ for t = 1 as in (16), which will be based on $\mathbf{N}^{\mathrm{F}}_{\mathrm{t=1}}$ and $\mathbf{X}^{\mathrm{F}}_{\mathrm{t=1}}$. For t = 2, we set $\mathbf{N}^{\mathrm{I}}_{\mathrm{t=2}} = \mathbf{N}^{\mathrm{F}}_{\mathrm{t=1}}$ and $\mathbf{X}^{\mathrm{I}}_{\mathrm{t=2}} = \mathbf{X}^{\mathrm{F}}_{\mathrm{t=1}}$, and repeat the same procedure as for t = 1. This process is then repeated (T–3) times whereupon we have T period recursively-dynamic solutions.

In calculating comparative-static solutions, we treat the model as an initial value problem and integrate the equation system. To treat the model as an initial value problem we only need to have at least one known solution of the equation system (Malakellis 2000, p. 124). That solution is the one generated using the initial values for all variables described in Section 2.1. In calculating recursively-dynamic solutions we are linking a series of multi-period solutions; here we are integrating the equation system through time. The solution technique gives us a recursive-dynamic framework.[10]

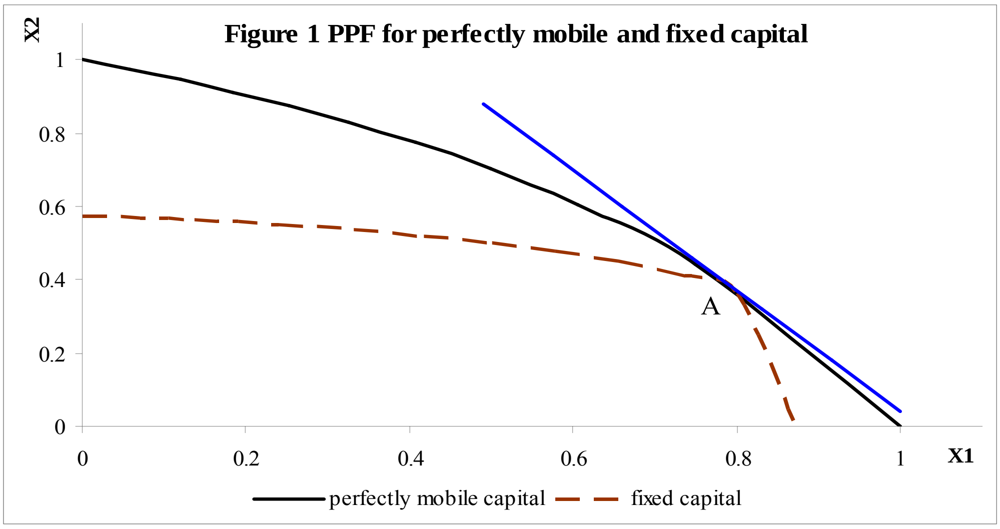
2.3 Factor mobility and production possibilities

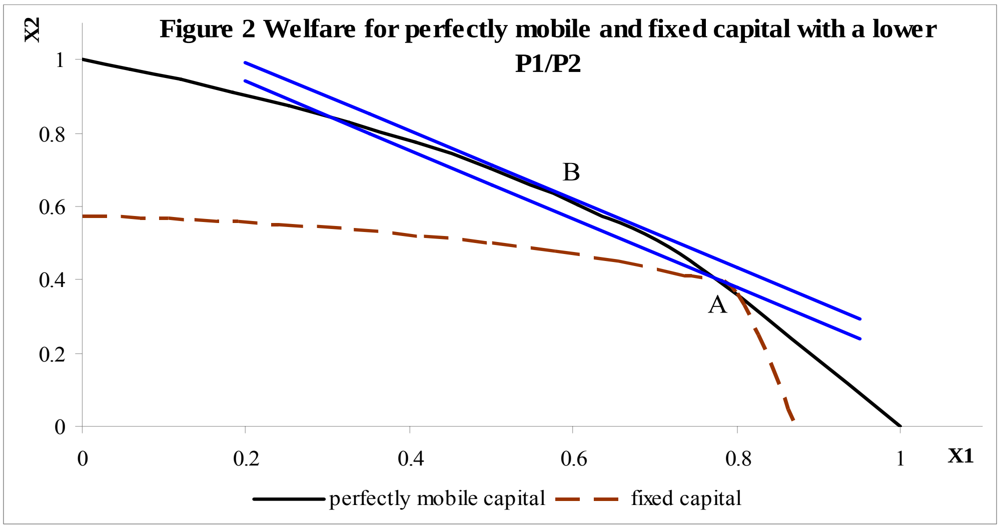
The degree of capital mobility affects production possibilities. If capital is perfectly mobile ($\theta = \infty$) and $\alpha \neq \beta$, the PPF will be non-linear and quasi-concave as shown by the solid line PPF in Figure 1. Thus, moving resources from industry 1 to industry 2 will result in $|\Delta X_1| > |\Delta X_2|$ reflecting diminishing returns in both labour and capital as they move from X_1 to X_2, i.e., a diminishing marginal rate of transformation (MRT). A diminishing MRT indicates that expanding the production of the capital-intensive good 2 requires transferring more and more labour and capital away from the labour-intensive good 1, so that the (absolute value of the) ratio of the marginal products, MP_2/MP_1, falls as we "transform" good 1 into good 2.

If we now assume capital is perfectly immobile ($\theta = 0$), the PPF will also be non-linear and quasi-concave but will exhibit greater curvature than before, as shown by the dashed line PPF in Figure 1; we can see this as follows. Imagine that the initial output mix is at point A in Figure 1, which is on the PPF for both economies, reflecting an equilibrium given an initial P_1/P_2 ($=PI_1/PI_2$). The initial P_1/P_2 is represented by the price line that is tangent to both PPFs at point A. Now increase the output of good 2. For a given increase in L_2, the (absolute value of the) slope of the transformation frontier will be decreasing, but will be decreasing faster the lower the degree of capital mobility. Moving labour out of good 1 and into good 2 will increase MP_1 and decrease MP_2. But for the same movement of labour into production of good 2, less capital will

[10] The model is implemented using the GEMPACK economic modelling software (Harrison and Pearson 1996).

be drawn out of sector 1 and into sector 2 the smaller is θ, so the decrease in MP_2 will be smaller the less mobile is capital. That is, for a given movement of labour out of sector 1 and into sector 2, the transformation frontier will be flatter the smaller the degree of capital mobility. For imperfectly mobile capital, $0 < \theta < \infty$, the PFF will lie between the dashed line and solid line PPFs in Figure 1; that is, it will exhibit less curvature than the perfectly immobile economy but more curvature than the perfectly mobile capital economy.





If we postulate a fall in P_1/P_2, with no change in PI_1/PI_2, as represented by the flatter price line in Figure 2, the perfectly mobile capital economy will move from point A in Figure 1 to point B in Figure 2; point A in the two figures are equivalent. Point B represents a lower X_1/X_2, which is consistent with a lower P_1/P_2. Welfare at point B is lower than at point A given our definition in equation (12); a change in X_1/X_2 with no change in PI_1/PI_2 will reduce welfare. Facing the same lower P_1/P_2, the best that the perfectly immobile capital economy can do is move slightly to the left of point A. This will also reduce welfare but by much less than the move from A to B. Thus, when these two economies are faced with same distortionary shift in relative prices, the perfectly mobile capital economy reaches a lower level of welfare than the perfectly immobile capital economy, although welfare falls for both economies. Clearly, an imperfectly mobile capital economy will reach a welfare level between that represented by point A and point B in Figure 2.

3. Evaluating market distortions

3.1 Comparative-statics

Applying the model outlined above, we initially impose a 10% import tariff/export subsidy on good 2; Table 1 reports the results of comparative-static solutions with varying degrees of capital mobility; that is, $\theta = \infty$, $\theta = 0$, $\theta = 1$. These three θ values represent perfectly mobile capital, fixed capital and imperfectly mobile capital. The choice of $\theta = 1$ for imperfect capital mobility results in K_1/K_2 moving proportionately with any change in Q_1/Q_2. We have no empirical justification for this parameter choice; it is purely a midpoint between the two extremes of perfectly mobile and fixed capital.

Table 1 Comparative-static solutions of a 10% import tariff/export subsidy on good 2 with varying degrees of capital mobility (percentage change)

Output		Labour		Capital		Wage	Rental rate		Welfare
good 1	good 2	indust 1	indust 2	indust 1	indust 2	rate	indust 1	indust 2	
Perfect capital mobility (PCM: $\theta = \infty$)									
-8.6865	8.2826	-5.7388	22.9550	-19.5866	4.8966	-3.1271	13.5508	13.5508	-0.2019
Imperfect capital mobility (ICM: $\theta = 1$)									
-4.5934	4.4439	-3.9237	15.6947	-7.2260	1.8065	-0.6971	2.8375	12.8497	-0.0747
								Mean:[a]	-0.0747
								Standard deviation:[a]	0.0049
Zero capital mobility (ZCM: $\theta = 0$)									
-2.3694	2.2580	-2.9529	11.8115	0.0000	0.0000	0.6013	-2.3694	12.4838	-0.0557

Source: model simulations.

[a] This is the mean and standard deviation in welfare with respect to varying θ by $\pm$ 50%. It is calculated by applying a Gaussian quadrature; see footnote 11 for an explanation of the assumptions underlying this method.

With perfect capital mobility (PCM), we observe that the tariff (subsidy) on good 2 attracts resources into industry 2, whose output expands, and out of industry 1, whose output contracts. As industry 2 is capital intensive, the wage-rental rate falls for both industries; at the same time, the domestic price ratio (P_1/P_2) falls (not reported). Welfare is now lower as there is now a divergence between the undistorted price ratio (PI_1/PI_2) and the MRT.

Where capital is imperfectly mobile (ICM) there is a smaller movement of resources due to $T_2 = 1.1$ Thus, the changes in industry output are also smaller. The wage-rental rate also falls by less, but now diverges between industries as the rental rate is specific for each industry. There is a greater fall in industry 2's wage-rental rate as it is capital intensive. The welfare loss is also much smaller than for PCM, as predicted by the diagrammatic analysis in Section 2.3.

Where there is zero capital mobility (ZCM), most effects, with one exception, are qualitatively similar to those already observed but quantitatively smaller. The exception is the wage-rental rate for industry 1, which now rises. For PCM and ICM, both labour and capital move out of industry 1 but more capital moves out of industry 1 than labour, so $\Delta MP_1^K > 0$ and $\Delta MP_1^L < 0$, which is reflected in a lower W/Q_1. But for ZCM only labour moves out of industry 1 and so $\Delta MP_1^K < 0$ and $\Delta MP_1^L > 0$, which is reflected in a higher W/Q_1.

The above results establish that for a given import tariff (export subsidy) the welfare loss will be lower, the lower degree of factor mobility, *ceteris paribus*. We measure the sensitivity of welfare with respect to the degree of capital mobility (θ) by applying a Gaussian quadrature that chooses the optimal number of simulations required to estimate the means and standard deviations for all endogenous variables (DeVuyst and Preckel 1997).[11] The calculated standard deviation in welfare is small relative to the mean: 0.005% compared with –0.075%, indicating that the welfare estimate is somewhat sensitive to the value of θ.

The results thus far establish that for a given import tariff (export subsidy) the welfare loss will be lower, the lower degree of factor mobility, *ceteris paribus*. This result also holds for a subsidy on the use of factors by industry 2. Imposing a subsidy on the use of both factors used by industry 2 is equivalent to imposing an output tax on industry 2. With fixed PI_1/PI_2, subsidising L_2 and K_2 reduces the price of employing factors facing industry 2 causing it to expand output. This leads to effects similar to those already observed. Thus, our results also hold for market distortions in general. Our results are also consistent with the discussion in Section 2.3. If a PCM economy faces a distorted relative price it will move from point A in Figure 1 to point B in Figure 2. A ZCM economy will only move slightly to the left of point A. When measuring the welfare loss in terms of the undistorted relative price (the price line in Figure 1), the PCM economy will have lower consumption possibilities than the ZCM economy. The result is intuitive: the more responsive is behaviour to a change in relative prices, the greater the resulting distortion in behaviour, and therefore welfare, from any given distortionary change in relative prices.

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[11] The procedure assumes that: (i) simulation results are well approximated by a third-order polynomial in the varying shocks and parameters; (ii) varying shocks and parameters have a symmetric distribution; (iii) shocks and parameters do not both vary at once; (iv) shocks and parameters either have a zero correlation or are perfectly correlated within a specified range (± 50%) (Arndt and Pearson 1996).

3.2 Dynamics: structural change in favour of good 2

Imagine now that our economy is more realistic and experiences structural change over time; this may be driven by many factors (see the discussion in Section 1). We capture ongoing structural change by moving the domestic price ratio in favour of good 2 or against it, over the course of a multi-period simulation. Multi-period simulations are implemented using the procedure described in Section 2.2. Initially we move the internal price ratio in favour of good 2, while also imposing the market distortion in period 1, and simulate outcomes using the three economies (PCM, ICM, ZCM).

In the first period, each economy experiences a shift in relative output in favour of good 2 that roughly matches that observed in the comparative-static solution (see Table 2). But here the shift towards good 2 is slightly greater as the domestic price ratio has also moved slightly more in favour of good 2, due to structural change in favour of good 2. From period 2 onwards, structural change in favour of good 2 drives more and more resources from industry 1 to industry 2 (Figure 3). Underlying these effects on relative outputs are changes in relative factor usage and prices that mirror the pattern of effects observed in the comparative-static solution.

The dynamic welfare effects in period 1 also approximate those observed in the comparative-static solution, with larger welfare losses for the more mobile economies. But over time the welfare losses are reversed in all economies, and the welfare-maximising ranking shifts so that by period 25 the less mobile economies experience lower welfare. These effects can be understood by reference to Figure 5, which shows a stylised PPF for the PCM economy.

Table 2 Recursive-dynamic solutions of a 10% import tariff/export subsidy on good 2 with varying degrees of capital mobility (percentage change)

Period	Output		Labour		Capital		Wage	Rental rate		Welfare
	good 1	good 2	ind 1	ind 2	ind 1	ind 2	rate	ind 1	ind 2	
					Perfect capital mobility (PCM: $\theta = \infty$)					
1	-9.620	9.127	-6.392	25.568	-21.458	5.365	-3.448	15.067	15.067	-0.200
5	-13.407	12.468	-9.117	36.466	-28.639	7.160	-4.720	21.339	21.339	-0.147
15	-23.289	20.601	-16.774	67.095	-44.638	11.159	-7.829	38.554	38.554	0.290
25	-33.851	28.468	-25.812	103.248	-58.191	14.548	-10.836	58.211	58.211	1.164
					Imperfect capital mobility (ICM: $\theta = 1$)					
1	-5.096	4.913	-4.364	17.457	-7.969	1.992	-0.765	3.121	14.282	-0.067
5	-7.154	6.799	-6.189	24.755	-10.918	2.729	-1.029	4.225	20.191	-0.004
15	-12.643	11.582	-11.209	44.836	-18.150	4.538	-1.615	6.729	36.312	0.372
25	-18.663	16.458	-16.941	67.763	-25.203	6.301	-2.074	8.744	54.546	1.070
									Mean:[a]	1.061
									Standard deviation:[a]	0.065
					Zero capital mobility (ZCM: $\theta = 0$)					
1	-2.632	2.495	-3.279	13.116	0.000	0.000	0.669	-2.632	13.872	-0.055
5	-3.712	3.448	-4.618	18.472	0.000	0.000	0.950	-3.712	19.598	-0.043
15	-6.632	5.850	-8.220	32.878	0.000	0.000	1.730	-6.632	35.177	0.074
25	-9.889	8.276	-12.204	48.817	0.000	0.000	2.637	-9.889	52.742	0.317

Source: model simulations.

[a] This is the mean and standard deviation in welfare with respect to varying θ by $\pm$ 50%. It is calculated by applying a Gaussian quadrature; see footnote 11 for an explanation of the assumptions underlying this method.

Figure 3 Relative output, X1/X2 (%-change)

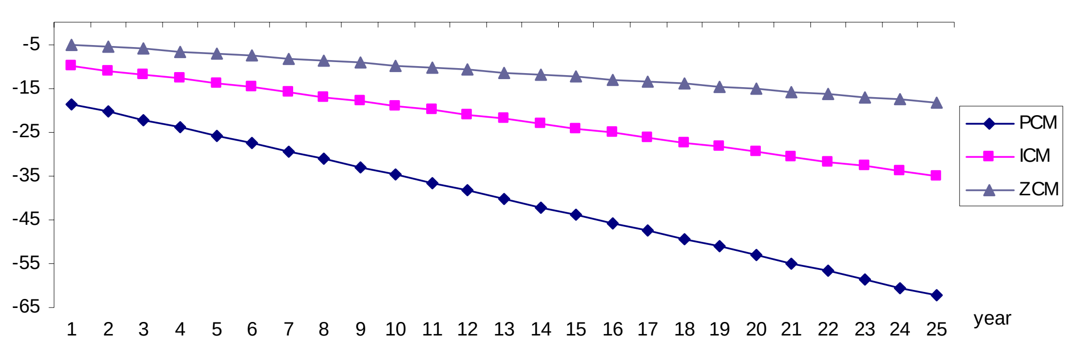
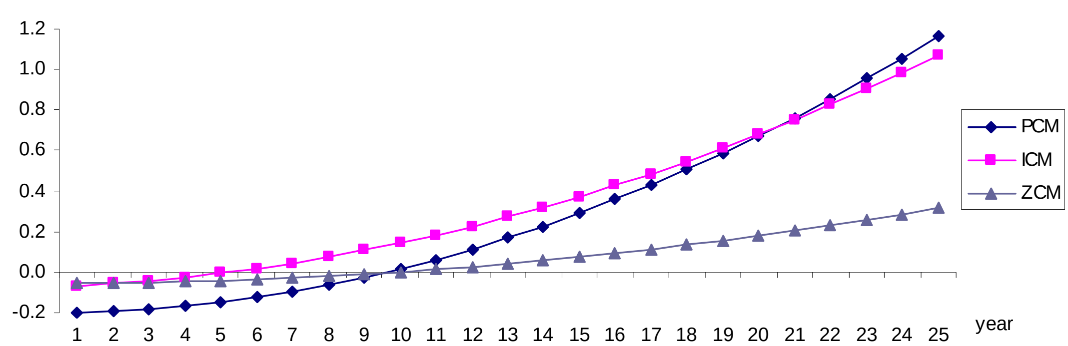
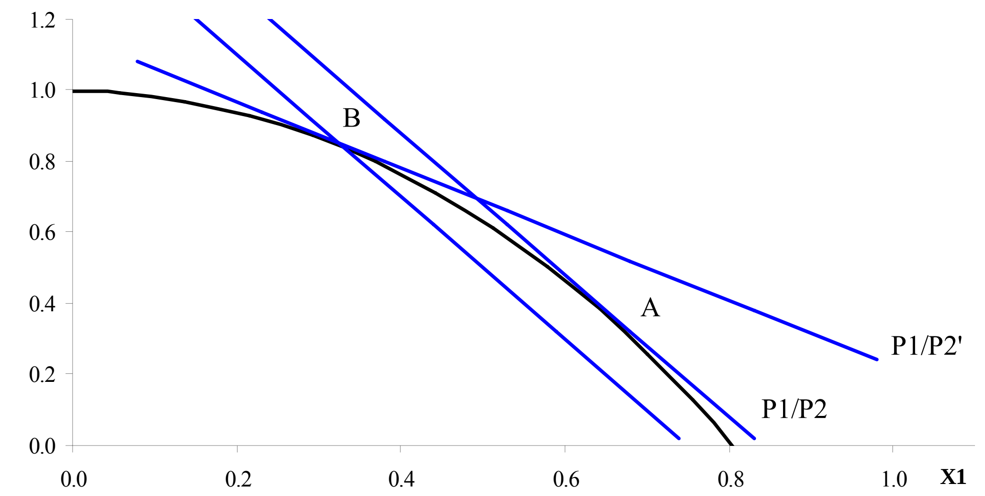


Figure 4 Welfare (%-change)



Note: PCM = perfect capital mobility; ICM = imperfect capital mobility; ZCM = zero capital mobility.

Figure 5 The PPF and structural change



The initial equilibrium is at point A, where the undistorted relative price ($P_1/P_2 = PI_1/PI_2$) is equal to the MRT. If an import tariff/export subsidy is imposed on good 2, raising the domestic price to P_2', the domestic price ratio falls to P_1/P_2' ($\neq PI_1/PI_2$) and the new equilibrium is a point B. The welfare loss can be measured in terms of good 2 by the vertical distance between the P_1/P_2 line that is tangent to point A and the P_1/P_2 line that goes through point B.

Over time, structural change in favour of good 2 will move the undistorted price line P_1/P_2 closer to the distorted price line P_1/P_2', so that the welfare loss as measured in terms of good 2 will be reduced. Where the undistorted price line increases to the point where the relative price equals the MRT, then welfare has returned to its initial level. This point is approximated in Figure 4 where the welfare change is zero, i.e., where it crosses the zero axis. Beyond this point, the economy continues to experience welfare gains due to ongoing structural change in favour of good 2.

The ability of an economy to take advantage of structural change favouring good 2 will depend on the degree of factor mobility. Where mobility is high, resources can move quickly to production of good 2. Where mobility is low, resources are slower to move into production of good 2. The rate of resource mobility is reflected in the slope of the welfare path in Figure 4.

The PCM economy has the steepest slope, followed by the ICM economy, and the ZCM economy has the flattest slope.

Figure 4 also makes it obvious that it matters at which point in time welfare is evaluated. At period 1, the comparative-static ranking is preserved. At period 2, the ICM economy is preferred to the ZCM economy, which is preferred to the PCM economy. By period 10, the PCM economy is preferred to the ZCM economy. By period 21, the PCM economy has moved ahead of the ICM economy in terms of welfare. These results suggest that not only is dynamic analysis to be preferred in evaluating market distortions, but also that a very long-run approach is also to be preferred.

3.3 Dynamics: structural change in favour of good 1

It is appropriate to ask: what would be the effects on our welfare analysis if structural change moved in favour of good 1 instead of good 2? Figure 6 shows the effects on relative output of structural change that disadvantages good 2 by a fall in the price of good 2, so that P_1/P_2 rises. As expected, resources now move out of industry 2 and into industry1. By period 10, the change in relative output favours good 1 and reverses the output mix change seen from the effects of the import tariff/export subsidy on good 2.

Figure 7 shows welfare path for each economy. We see that welfare ranking ZCM $\succ$ ICM $\succ$ PCM is preserved in presence of structural change favouring good 1 until period 10. After that, the ranking flips so that PCM $\succ$ ICM $\succ$ ZCM. Furthermore, the welfare effects move from negative to positive. As before, we see that structural change can reverse the sign of the welfare effects of market distortions. We see also that the size of the welfare effect strongly depends on the assumed degree of capital mobility. The PCM economy predicts a 1.2% gain in welfare by period 25 whereas a ZCM economy predicts a 0.3% gain; a ratio of 4. A similar ratio was observed when structural change favoured good 2.

Figure 6 Relative output, X1/X2 (%-change)

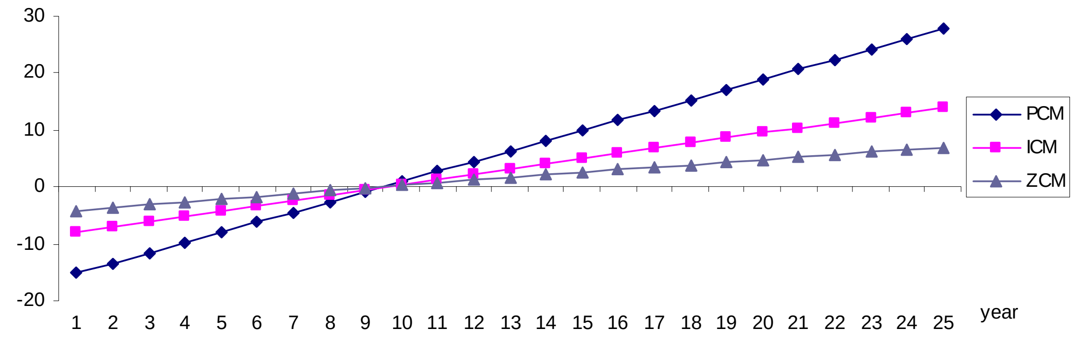
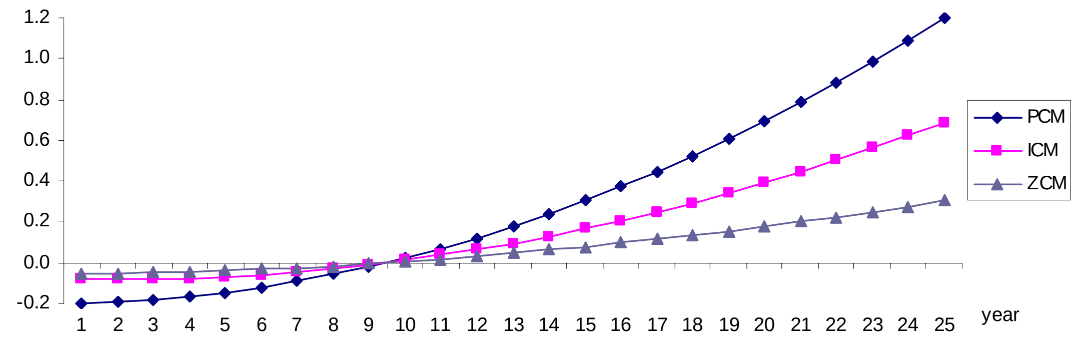


Figure 7 Welfare (%-change)



Note: PCM = perfect capital mobility; ICM = imperfect capital mobility; ZCM = zero capital mobility.

Regardless of whether structural change favours the good upon which the market distortion is imposed, the comparative-static welfare effects are reversed, from negative to positive, when assessed in a dynamic framework that captures ongoing structural change in the economy. The degree of reversal in the welfare effects will depend on the assumed degree of factor mobility in the economy.

The above results are suggestive of two things. First, the proper framework within which to evaluate market distortions is dynamic. That is, one in which information about the future course of the economy can be incorporated. Second, the degree of factor mobility that is assumed in any analysis of market distortions is important to the size of the welfare effects. In general, estimates of welfare effects (negative and positive) will be larger the greater the assumed degree of factor mobility.

3.4 Comparative-dynamics: structural change in favour of good 2

So far we have assessed the importance of structural change and capital mobility on evaluating market distortions by comparing comparative-static solutions with dynamic solutions. Our results suggest that dynamic analysis that incorporates structural change and imperfect factor mobility can give very different results from comparative-static analysis. When market distortions *are* evaluated using dynamic analysis, is structural change and factor mobility any less important? That is, if we compare dynamic solutions with different assumptions regarding structural change and factor mobility, will welfare effects vary significantly? To answer these questions, we need to compare across dynamic solutions that assume different forms of structural change and factor mobility, i.e., we need to generate comparative-dynamic results and compare the outcomes.

Comparative-dynamic results are the typical way that market distortions are evaluated in a dynamic framework; for some examples, see Ballard et al. (1985); Dixon and Rimmer (2002); Ishii et al. (1985); Kouparitsas (2001); and Walmsley et al. (2006). Comparative-dynamic results are where a baseline simulation is first run, which incorporates information on the future time path of the economy excluding any policy change, such as a market distortion. Then, a policy simulation is run that incorporates the baseline time path plus the distortion to be evaluated. These two dynamic solutions are then compared to yield comparative-dynamic results.[12]

To compare across dynamic solutions, we take as our baseline ongoing structural change as already applied in the earlier analysis. In this section we assume structural change that favours good 2. We then apply a market distortion on good 2 as our policy simulation. Finally we

[12] Note that comparative-dynamic results can be generated by recursively-dynamic models or by comparative-dynamic (or intertemporal) models (see footnote 2). Some of the dynamic analysis referenced above applies recursively-dynamic models (e.g., Dixon and Rimmer 2002) and others apply comparative-dynamic (or intertemporal) models (e.g., Ballard et al. 1985).

compare the two time paths of the economy. We do this for each of the three economies; PCM, ICM and ZCM.

The baseline path for relative output (X_1/X_2) for each of the three economies (PCM, ICM, LCM) is presented in Figure 8. In each economy we observe a shift in relative output in favour of good 2; however, as expected the shift is less marked the less mobile capital is between industries. Underlying these effects on relative outputs are changes in relative factor usage and prices that mirror the pattern of effects observed in the comparative-static solutions discussed in Section 3.1.

Figure 9 compares the baseline paths of welfare for the three economies; given structural change favouring good 2, we see larger welfare improvements in the more mobile economies. For the least mobile economy (LCM), slower resource reallocation leads to lower growth rates in welfare. After 25 periods, PCM welfare has grown by 1.37%, ICM welfare by 0.98%, and LCM welfare by 0.38%. Thus, the PCM economy experiences real income growth that it is more than three times that of the LCM economy.

We now apply a tariff of 10% on good 2 and calculate the deviations from baseline over the 25 periods: Table 3 presents results at various points in time; Figures 10 and 11 present the time path of relative output and welfare. Period 1 effects for each economy almost exactly match the comparative-static results discussed in Section 3.1 (Table 1). We see the import tariff/export subsidy on good 2 distorts production in favour of good 2 and gives rise to welfare losses that are proportional to the assumed degree of capital mobility. Beyond period 1, the deviations in relative output (X_1/X_2) are relatively unchanged, but do exhibit a continuing decline in X_1/X_2 relative to baseline.

Figure 8 Baseline relative output, X1/X2 (%-change)

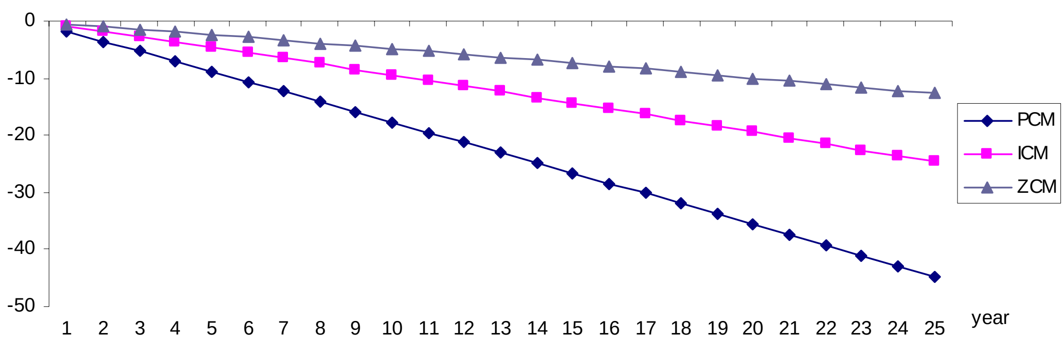
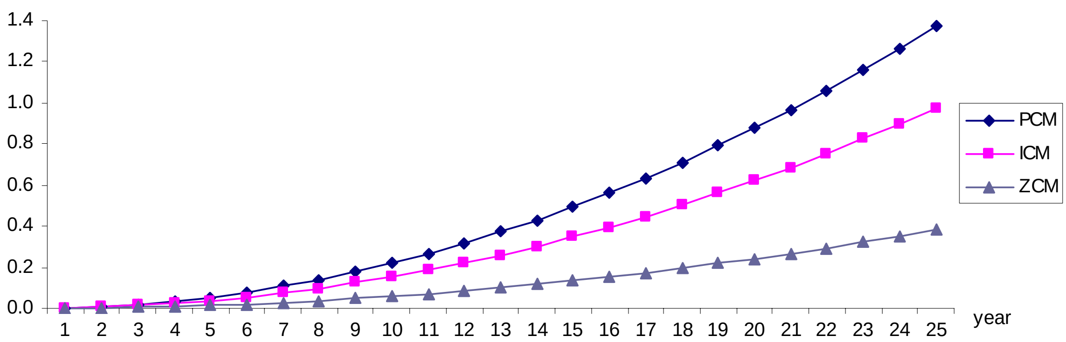


Figure 9 Baseline welfare (%-change)



Note: PCM = perfect capital mobility; ICM = imperfect capital mobility; ZCM = zero capital mobility.

In contrast, the welfare effects exhibit an asymmetrical response. The models embodying extreme assumptions regarding capital mobility (i.e., PCM and ZCM) exhibit welfare losses that, like relative output, are relatively unchanged over time. The model assuming imperfect capital mobility exhibits annual welfare gains that by period 12 gives a zero welfare effect, and by period 25 gives a welfare *gain* of 0.093%. Thus, the standard trade models of Hecksher-Ohlin (PCM here) and specific factors (ZCM here) give a standard result when comparing dynamic equilibria; a non-standard trade model that assumes sluggishness in the movement of factors between industries (ICM) gives an unexpected result. We now observe the sluggish factor mobility case exhibiting the largest welfare gains, giving a new ranking from those already observed with comparative-static and recursively-dynamic solutions.

Table 3 Deviations from baseline of a 10% import tariff/export subsidy on good 2 with varying degrees of capital mobility (percentage change)

Period	Output good 1	Output good 2	Labour ind 1	Labour ind 2	Capital ind 1	Capital ind 2	Wage rate	Rental rate ind 1	Rental rate ind 2	Welfare
				Perfect capital mobility (PCM: $\theta = \infty$)						
1	-8.811	8.173	-5.867	22.830	-19.697	4.790	-3.127	13.551	13.551	-0.202
5	-9.346	7.760	-6.420	22.361	-20.169	4.391	-3.127	13.551	13.551	-0.202
15	-10.997	6.900	-8.124	21.384	-21.623	3.557	-3.127	13.551	13.551	-0.203
25	-13.281	6.228	-10.482	20.621	-23.634	2.906	-3.127	13.551	13.551	-0.204
				Imperfect capital mobility (ICM: $\theta = 1$)						
1	-4.656	4.433	-3.994	15.674	-7.260	1.798	-0.690	2.807	12.848	-0.068
5	-4.922	4.389	-4.291	15.589	-7.401	1.763	-0.658	2.677	12.839	-0.042
15	-5.687	4.283	-5.151	15.363	-7.799	1.684	-0.565	2.291	12.812	0.025
25	-6.633	4.180	-6.216	15.109	-8.281	1.614	-0.444	1.797	12.778	0.093
									Mean:[a]	0.090
									Standard deviation:[a]	0.004
				Zero capital mobility (ZCM: $\theta = 0$)						
1	-2.402	2.256	-2.993	11.800	0.000	0.000	0.610	-2.402	12.481	-0.056
5	-2.538	2.247	-3.162	11.751	0.000	0.000	0.645	-2.538	12.472	-0.057
15	-2.915	2.222	-3.630	11.616	0.000	0.000	0.742	-2.915	12.444	-0.061
25	-3.354	2.193	-4.174	11.458	0.000	0.000	0.856	-3.354	12.413	-0.064

Source: model simulations.

[a] This is the standard deviation in welfare with respect to varying θ by $\pm$ 50%. It is calculated by applying a Gaussian quadrature; see footnote 11 for an explanation of the assumptions underlying this method.

Figure 10 Deviation from baseline, relative output, X1/X2 (%-change)

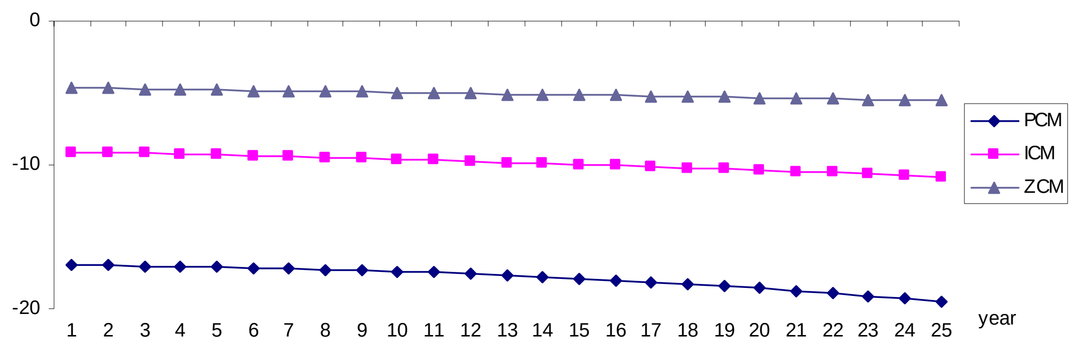
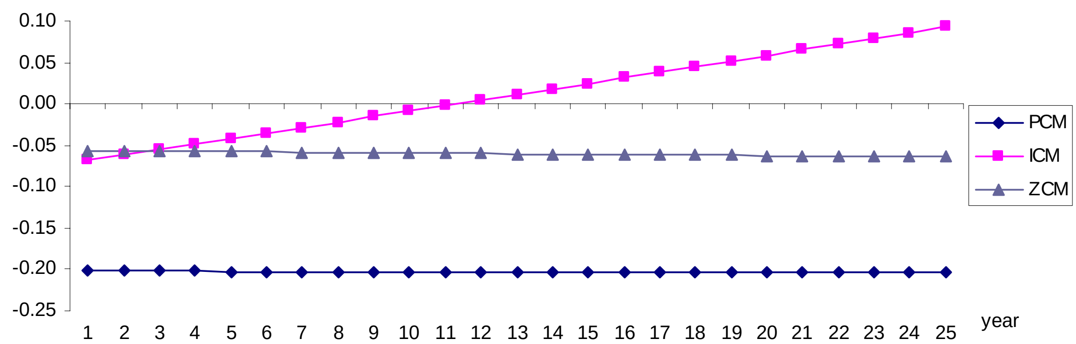


Figure 11 Deviation from baseline, welfare (%-change)



Note: PCM = perfect capital mobility; ICM = imperfect capital mobility; ZCM = zero capital mobility.

The reason for this asymmetrical result is similar that already given earlier using Figure 5. In the baseline, the equilibrium in each period is one in which the undistorted relative price is equal to the MRT, i.e., at a point like A in Figure 5. Here, $P_1/P_2 = PI_1/PI_2 = \mathrm{MP}_2/\mathrm{MP}_1$. Imposing an import tariff/export subsidy on good 2 in period 1 raises the domestic price to P_2', so the domestic price ratio falls to (P_1/P_2') and the new equilibrium is a point B, where $P_1/P_2' = \mathrm{MP}_2/\mathrm{MP}_1 > PI_1/PI_2$. This represents a welfare loss.

But structural change in favour of good 2 from period 2 onwards will continually move the undistorted price line PI_1/PI_2 closer to the distorted price line P_1/P_2', so that the difference between P_1/P_2' (= $\mathrm{MP}_2/\mathrm{MP}_1$) and PI_1/PI_2 will be reduced in every period. Eventually welfare will return to its initial level (period 12 here); and beyond this point the economy continues to experience welfare gains due to the ongoing structural change in favour of good 2. Thus, a regime of positive but unequal indirect tax rates may result in an output mix that enhances welfare in the presence of underlying structural change in favour of the taxed good. Here tax policy speeds the adjustment process, i.e., the tariff provides an additional incentive to producers to intensify the production of the commodity favoured by structural change.

This mechanism is not present in the extremes of perfect capital mobility and fixed capital. In the case of perfect capital mobility the initial loss in period 1 due to the tariff is so great that it can never be undone by subsequent structural change in favour of the taxed good. The movement of factors in response to the tariff is so great that the undistorted price line in Figure 5 (PI_1/PI_2) can never move enough towards point B to remove the welfare loss. In the case of zero capital mobility, the initial loss in period 1 due to the tariff is small. But the limitation here is that there is not enough mobility of factors in the economy to take advantage of subsequent structural change in favour of the taxed good, which would otherwise help to ameliorate the welfare loss experienced in period 1.

3.5 Comparative-dynamics: structural change in favour of good 1

Here we compare dynamic equilibria where we apply a market distortion on good 2 in the presence of structural change that favours good 1. We know from the previous section that structural change that favours a particular good will, over time, cause relative output to move in favour that good. We also know from the previous analysis that the shift in relative output will be less marked the less mobile capital is between industries. We take these baseline effects as understood.

We now apply a tariff of 10% on good 2 and calculate the deviations from baseline over 25 periods; Figures 12 and 13 present the time path of the deviations in relative output and welfare from baseline. The deviations in relative output almost exactly match those observed in the previous section: the import tariff/export subsidy on good 2 distorts production in favour of good 2. The welfare deviations for the PCM and ZCM economies are also very close to those observed when structural change favoured good 2 (the taxed good), whereas those for the ICM economy are the opposite of those observed when structural change favoured the taxed good.

We now observe another form of asymmetry in the effects of factor mobility and its interaction with structural change. Where capital is either perfectly mobile or fixed, the long-run loss is well approximated by the loss in period 1 in comparative-dynamic results or comparative-statics regardless of the direction of structural change. But where factor mobility is sluggish, the long-run welfare effect of a market distortion will depend on the underlying movements in the economy. If the market distortion favours a good that is experience favourable structural change, then, depending on the degree of factor mobility, the market distortion may improve welfare over time. Whereas if the market distortion favours a good that is being disadvantaged by structural change, then, the market distortion will reduce welfare over time and the reduction will greater the greater the degree of factor mobility.

Figure 12 Deviation from baseline, relative output, X1/X2 (%-change)

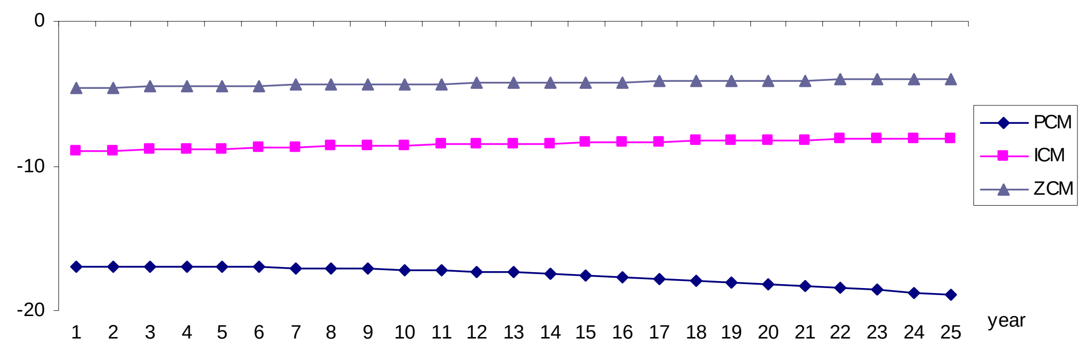
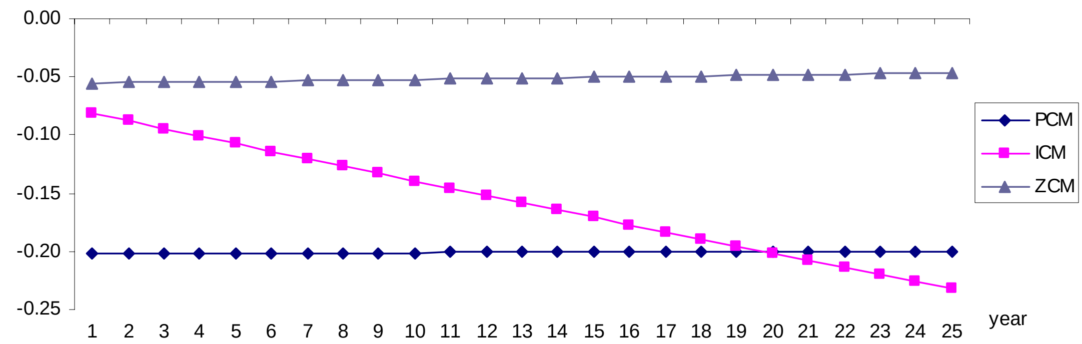


Figure 13 Deviation from baseline, welfare (%-change)



Note: PCM = perfect capital mobility; ICM = imperfect capital mobility; ZCM = zero capital mobility.

Here the baseline equilibrium in each period is one in which the undistorted relative price is equal to the MRT ($P_1/P_2 = PI_1/PI_2$ = MP_2/MP_1). Imposing an import tariff/export subsidy on good 2 in period 1 raises the domestic price to P_2', so the domestic price ratio falls to P_1/P_2' and the new equilibrium is a point where P_1/P_2' = $MP_2/MP_1 > PI_1/PI_2$. This represents a welfare loss. Structural change in favour of good 1 from period 2 onwards will continually move the undistorted price line PI_1/PI_2 further away from the distorted price line P_1/P_2', so that the difference between P_1/P_2' (= MP_2/MP_1) and PI_1/PI_2 will *increase* in every period. This process will continue as long there exists structural change favouring good 1. Here, a regime of positive but unequal indirect tax rates results in an output mix that decreases welfare in the period that the market distortion is imposed and subsequently decreases it further as we move through time.

This mechanism is not present in the extremes of perfect and fixed capital mobility. In the case of perfect capital mobility the initial loss in period 1 due to the tariff is so great that it can never be made much greater by subsequent structural change in favour of the non-taxed good. In the case of zero capital mobility, the initial loss in period 1 due to the tariff is small. But the limitation here is that there is not enough mobility of factors in the economy to worsen the disadvantage of subsequent structural change in favour of the non-taxed good.

3.6 Comparative-dynamics: the relationship between factor mobility and welfare

The results in Sections 3.3 and 3.4 suggest that where capital is imperfectly mobile ($0 < \theta < \infty$), there is a monotonic relationship between the degree of capital mobility and welfare for a given pattern of structural change. Here we test this proposition by deriving the relationship between θ and welfare for a given pattern of structural change, by performing a grid search for θ in the range $1 \leq \theta \leq 5$ using a uniform grid where the distance between grid points = 1.

Figures 14 and 15 plot these results and also include the results for $\theta = 0$ and $\theta = \infty$ for reference. We see that for a given pattern of structural change, higher degrees of capital mobility will decrease (increase) welfare gains (losses). Furthermore, the time path of welfare deviations will "flatten" as capital is assumed to be more mobile until it approaches the time path of perfect capital mobility.

Figure 14 Deviation from baseline, welfare, structural change favouring good 2 (%-change)

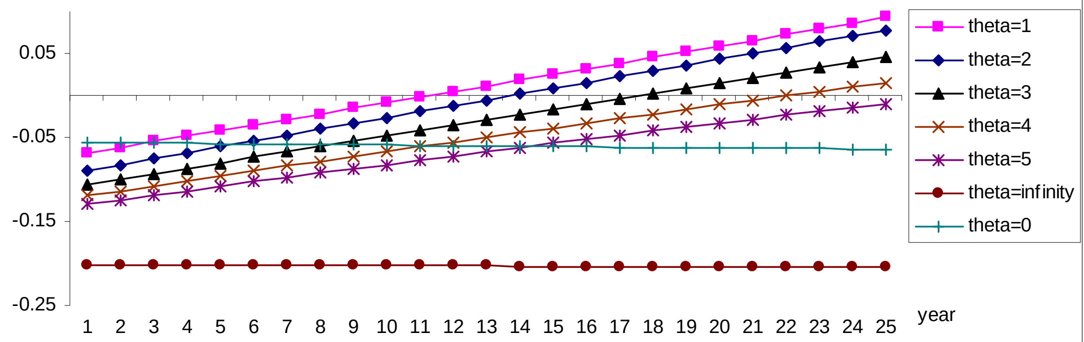
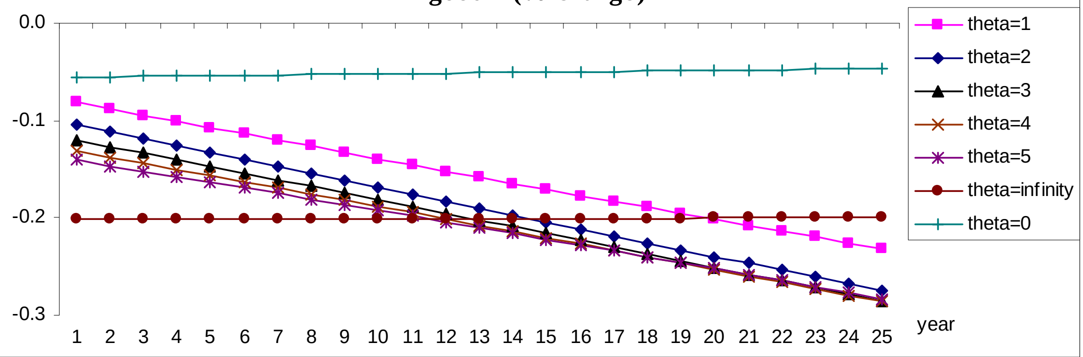


Figure 15 Deviation from baseline, welfare, structural change favouring good 1 (%-change)



Note: theta = θ, which controls the degree of capital mobility. Where $\theta = \infty$ capital is perfectly mobile; where $\theta = 0$ capital is perfectly immobile.

These results suggest that for $0 < \theta < \infty$ there is a monotonic relationship between the degree of capital mobility and welfare for a given pattern of structural change, but for $0 \leq \theta \leq$ the relationship is non-monotonic. That is, there is a highly non-linear relationship between the degree of factor mobility and welfare in the presence of structural change, regardless of the nature of the structural change. The sensitivity analysis reinforces the earlier findings suggesting that degree of factor mobility be treated as a parameter and subject to sensitivity analysis when evaluating the welfare effects of market distortions. As such, comparative-dynamic analyses that assume perfect interindustry factor mobility, which applies to most of the references cited in Section 3.3, are likely to be overestimating the welfare effects of market distortions when structural change favours the taxed good, and underestimating the welfare effects of market distortions when structural change disadvantages the taxed good.

4. Conclusion

We evaluate the welfare-maximising outcome of market distortions in the presence of two commonly observed empirical phenomena: (i) ongoing structural change; (ii) imperfect factor mobility. Our analytical framework applies a simple, general-equilibrium model with two goods and two factors of production, representing a small, open economy.

Traditional welfare analysis of market distortions ignores the possible importance of structural change and imperfect factor mobility on welfare outcomes. Here we test this importance by comparing the welfare effects of comparative-static solutions, which cannot explicitly account for structural change and imperfect factor mobility, with recursively-dynamic solutions, which do explicitly account for structural change and imperfect factor mobility. The comparison demonstrates that the degree of factor mobility strongly affects the sign of the welfare effect when assessing market distortions. Comparative-static solutions predict that market distortions always yield lower welfare but that the welfare loss is greater the greater the degree of factor mobility. Recursively-dynamic solutions reverse this ranking via two mechanisms. First, in the presence of structural change and given an appropriate length of run, market distortions can yield welfare gains. Second, the welfare gain will be greater the greater the degree of factor mobility.

We also compare welfare outcomes using comparative-dynamic analysis (which compares baseline and policy simulations to evaluate perturbations to the economy) under different assumptions regarding structural change and factor mobility. We find a non-monotonic relationship between degree of capital mobility and welfare for a given pattern of structural change. For a given degree of imperfect factor mobility, structural change that favours the taxed good will, over time, generate welfare gains, whereas structural change that disadvantages the taxed good will, over time, generate welfare losses. As the degree of factor mobility is decreased, the welfare gains generated by structural change favouring the taxed good will increase and the welfare losses generated by structural change disadvantaging the taxed good will also increase.

The counter-intuitive results for the welfare-maximising outcome of market distortions are generated by incorporating structural change and imperfect factor mobility in the analysis. Structural change moves the economy away from the initial market-distorting equilibrium generated by a tax. In doing so, the undistorted relative price may move closer or further away from the distorted relative price that includes the tax. In the case of the former, the initial welfare loss is reduced; in the case of the latter, the welfare loss is increased. Where factors are perfectly mobile or some factors are perfectly immobile, structural change will either move resources very quickly (perfect factor mobility) or very slowly (some factors are perfectly immobile), so that initial welfare loss is also the long-run welfare loss. Where factors are imperfectly mobile, the initial welfare loss can be reversed over time, if structural change allows encourages a sufficient amount of resources to move to the production of the taxed good.

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