Economic (Dis)integration in the Presence of Evolutionary Learning

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Abstract

We use a two-factor, two-sector model to study the effects of economic integration and its reversal in the presence of input-generated external economies in one of the sectors. The equilibrium selection problem that arises is solved by applying a simple trial-and-error learning rule. Economic integration can take individual economies ridden with coordination failures to better equilibria, i.e., can solve the coordination problem. We show that integration (and disintegration) may generate cycles in wages, rentals and the sectoral allocation of factors.

Keywords: economic (dis)integration, input-generated externalities, coordination failures, learning rule, simulation.

JEL classification: F15; F16; F37

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I - Introduction

Recent decades have been marked both by an increasing number of attempts to integrate countries regionally and by the simultaneous breaking up of former unions. Two rather spectacular success stories of union formation are familiar: The European Union and NAFTA. But the list is not confined to these highly publicized agreements. De Torre and Kelly (1992) cite 17 other regional integration agreements in the Western Hemisphere, eight in Africa and eight in Asia-Pacific and the Middle East. The expansion (and the deepening) of economic integration in different regions of the world has led to the pooling of resources as well as coordination of public policies.[1] Equally prominent are examples of break-away regions. The dissolution of the Soviet Union and the Yugoslav Federation has spawned several mini-republics. Recently East Timor voted for independence from Indonesia. One can go on.

Our aim in this paper is to study the consequences of the formation of economic unions as well as of their dissolution. Specifically, we focus on the (dis)integration in both goods and factor markets. We thus, analyze the formation of free trade areas as well as unions where capital and/or labor moves freely among union members. One of the main benefits of integration is the increased return from a larger scale of production. To the extent that there are spillovers across firms, a larger scale leads to more learning by doing by firms and to higher economy-wide productivity. We take this observation as one our two main points of departure. In thinking about such spillovers, we follow Arrow (1962), Sheshinski (1967), and Romer (1986) by supposing that the external economies of scale are generated through the industry level capital input. This is a short-hand way of stating that firms learn by doing and this learning works through each firm's investment. Furthermore, as in these papers, we take each firms's knowledge to be a public good that any other firm can access without incurring any costs.

In this context, it is important to note that external economies are a reality and not a mere theoretical possibility. A number of recent studies have found evidence for increasing returns to scale at the industry and firm levels. Using data on trade flows for 71 countries for the period 1972-92, Antweiler and Trefler (2002) find evidence of economies of scale in a third of the 34 industries they

[1] Baldwin and Venables (1995) provide a useful survey of recent literature on regional economic integration.

study. Also, Hanson (2001) and Paul and Siegel (1999) find support for small but significant scale economies in manufacturing. Furthermore, Paul and Siegel find that both external and internal economies from the point of view of the firm are important in explaining industry-level scale economies. Other studies that have found evidence of increasing returns to scale are Kim (2000) and Krishna and Mitra (1998) for Korean and Indian industries respectively. While the former uses industry-level data, the latter use firm-level data.

The second main point we want to get across is based on the observation that though economic integration presents new opportunities to economic agents, it also confronts them with a new environment. One consequence of this is that before they can be exploited, such opportunities need to be deciphered and learned about. The problem that agents face becomes more complex in the presence of externalities since, as is well-known, externalities may give rise to multiple equilibria, as, for instance, in Panagariya (1981) and coordination problems, as in Krugman (1991), Matsuyama (1991) and Rodrik (1996). The model we present is based on Karayalcin and Mitra (1999) and differs from those of Panagariya, Krugman and Matsuyama in that it incorporates a second factor of production: capital. This proves important because Karayalcin and Mitra (1999) show that for an economy to be faced with coordination failures, it must have a sufficient amount of capital.[2]

More importantly, observers of the process of learning and adjustment are acutely aware that it is not instantaneous and is characterized by a significant amount of trial and error. To formalize such a process, we postulate a learning rule under which agents gradually learn about their environment. The rule we adopt gives rise to a dynamic process under which the proportion of players that earn above (below) average payoffs increases (decreases) over time.[3] As a consequence the joint movements of capital and labor flows turn out to be quite rich.

The plan of the paper is as follows. We first study a small open economy within which externalities give rise to multiple equilibria and show which of these are learning stable. We then turn our attention to the growth path of an integrated economy and its components, starting from one of the

[2] Unlike in Rodrik (1996), the "bad" equilibrium that a coordination failure gives rise to in the model presented below always belongs to the set of equilibria (even for countries that are capital rich). Furthermore, unlike Rodrik (1996) we study a simple learning rule that agents follow. This is the same rule used, most recently, by Sethi and Somanathan (1996) in a study of the evolution of social norms.

learning-stable pre-integration steady states. The types of integration we study range from one where countries form a free trade area to one where they fully integrate their factor markets. Regardless of the type, the post-integration transition phase, where agents gradually learn to coordinate and eliminate inefficiencies, is characterised by transitional cycles in the allocation of factors across sectors and in their rates of return. However, along the adjustment path the integrated economy enjoys a higher per-capita income as it benefits from a larger scale and allocates factors more efficiently across different sectors. Finally, we explore the consequences of the breaking up of an existing economic union. Not surprisingly, we show that this process reduces per-capita incomes of all parties concerned as the benefits from scale economies are lost. Again the transition path is characterized by cyclical movements of rates of return and the allocation of factors across different uses. We also find that a small break-away region ends up fully specializing in a "low-tech" sector.

Here it also should be pointed out that there exist only a few empirical studies that have looked at the impact free trade areas on wages, wage inequality, productivity, GDP, etc. of member countries. Hanson (2002) finds that in the post-NAFTA period, as in the US, there has been a rise in the returns to skill in Mexico. He does not find evidence of wage convergence between the two countries. Robertson (2003) finds from household surveys very little evidence of faster wage convergence following the NAFTA. The exceptions are the wages of more educated Mexicans which have demonstrated faster conditional convergence following NAFTA. Trefler (2001) finds that the Canada-U.S. Free Trade Agreement (FTA) resulted in a significant increase in the productivity growth in Canadian manufacturing. Finally, a recent study by the Congressional Budget Office (CBO, 2003) combines its estimates with those of other recent studies to conclude that "NAFTA has increased annual US GDP, but by a very small amount – probably no more than a few billion dollars, or a few hundredths of a percent." The study also concludes that the increase in Mexican GDP in dollar terms has been roughly the same, which due to the much smaller size of the economy represents a much larger growth rate.

Our analysis in this paper and our results clearly are to a great extent consistent with the above studies. In this context, one should first note that the above FTA's, especially NAFTA were both about trade and investment liberalization. Also, as in the above studies, we find the possibility of growth in productivity, increase in GDP and an increase in wage premium (if capital in our model is interpreted as human as well as physical capital).

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[3] Gale et al. (1995) and Börgers and Sarin (1997) show that these dynamics can be derived from individual learning behavior.

II - The Model

The points that we want to get across can be most easily made in the context of a small open economy (so that relative prices can be treated parametrically) that can produce two goods labeled, for ease of exposition, "high-tech" and "low-tech". The outputs of the two sectors are given by the following production functions:

$$Y = A(K_y)F(K_y, L_y) \qquad (1)$$

$$X = G(K_x, L_x) \qquad (2)$$

The functions F and G are constant returns to scale and have the usual neoclassical properties. However, the capital employed by the "high-tech" good sector generates an externality. This externality is captured by the function A in (1). We assume that individual firms treat A as parametric; i.e., the returns to scale is external to the firms. Note also that the good Y is capital intensive while X is labor intensive.

In general, the presence of such an externality implies that the production possibilities frontier (PPF) as viewed by private agents differs from that faced by a hypothetical social planner that internalizes this externality. Subject to the economy-wide resource constraints, the social PPF (SPPF) is obtained by equating the social marginal rates of technical substitution across sectors, while the private PPF (PPPF) is obtained by equating the private marginal rates of technical substitution.

It is a straightforward, though tedious, exercise to show that once we follow the literature in specializing the production functions given in (1) and (2) to the forms[4]

$$Y = (K_Y^{1-\delta})(K_Y^{\alpha} L_Y^{1-\alpha}), \quad \alpha \in [0,1], \;\; \delta \in [0,1], \qquad (1')$$

$$X = K_X^{\beta} L_X^{1-\beta}, \quad \beta \in [0,1] \qquad (2')$$

both the SPPF and the PPPF are downward sloping and (under the condition $\sqrt{\beta} < \alpha < 2\beta$) convex when the economy specializes in X production and concave when the economy specializes in Y production.[5] (See Figure 1). Further, the private PPF lies below the social PPF implying that the

[4] Wong (1995) shows that when these constant elasticity functions are replaced by their more general, variable elasticity counterparts a number of results relevant to the discussion of externalities continue to hold.

[5] See Karayalcin and Mitra (1999) for the detailed derivations and discussion.This shape is called the Herberg-Kemp curvature (see Wong (1995)). Intuitively, it is easy to see that the postulated externality would give rise to a convex section of the PPF.

decentralized equilibrium is inefficient. This is because (1) private agents, unlike the social planner, do not internalize the externality and (2) the input-generated externality (unlike an output-generated one the literature has focused on) drives a wedge between social and private rates of technical substitution.

There exists, of course, an additional inefficiency, emphasized in the existing literature: at a given ratio of outputs, the slope of the PPF differs from the world relative price (i.e $dY/dX>p$, where p denotes the exogenously given relative price of the low-tech good).

It is well known that externalities give rise to multiple equilibria and they indeed do arise in the present framework. To see the types of multiple equilibria that arise in this framework, it is useful to inspect Figure 2 which depicts the private marginal opportunity cost, c, of the "low-tech" good in terms of the "high-tech" good:

$$c = c(X) = \frac{AF_L}{G_L} = \frac{AF_K}{G_K} \qquad (3)$$

(where we have used (1'), (2') and the equality of marginal rates of substitution). This cost c is a concave function of X with an interior maximum if increasing returns in the production of the high-tech good are relatively low (i.e. if $\alpha^2 > \beta$).[6] Otherwise, c monotonically decreases with $X \in [0, X_{\max}]$ (where $X_{\max}$ denotes the level of X when the economy specializes in the production of the low-tech good). Three possible equilibria labelled A, B, and C when $p=p_0$ are depicted in Figure 2. A and B are equilibria because the private opportunity cost equals the world relative price at these points. At C the private opportunity cost of producing X is less than the world relative price p and so there exists an incentive to increase the production of X. This cannot be done, however, since this sector has already absorbed all of the resources of the economy. Furthermore, note that the private opportunity cost, c, is strictly positive even when the economy specializes in the high-tech good (i.e., the slope of the PPPF is strictly negative when $X \in [0, X_{\max})$) and that as $X \to X_{\max}, c \to 0$, with the implication that specialization in the low-tech good always belongs to the set of possible equilibria. However, it is

To understand why there is a concave region, consider the following. As K_Y goes to infinity, (1) and (1') imply that dA/dK_Y approaches zero. Stated differently, when there is an increase in the capital employed in the Y sector, the extent of marginal external returns falls.

[6] Following the growth literature we henceforth set $\alpha = \delta$ for simplicity. In this case, $2 - \alpha$ measures the returns to scale, so that a higher α means lower returns to scale. For technical details on this and what follows see Karayalcin and Mitra (1999).

straightforward to show that the former equilibrium yields a higher rental rate and a lower wage rate than the latter. Intuitively, this follows from the fact that the high-tech sector, which generates a higher level of income, is capital intensive.

III. Economic Integration and Learning

Following Karayalcin and Mitra (1999), we adopt a simple learning rule, formalized by replicator dynamics, to solve the equilibrium selection problem in the pre- and post-integration environments. This choice is motivated by the fact that replicator dynamics arise naturally in contexts where agents learn about the economic environment in which they find themselves. And that the adjustment displayed under such dynamics is qualitatively similar to those generated by other learning rules.

The replicator dynamics learning process can be formalized for the two types of agents present in our model, namely, owners of capital and labor as[7]

$$\dot{\theta} = \theta(r^Y - \bar{r}) \equiv \phi(\theta, \lambda), \;\; \phi_\theta < 0, \;\; \phi_\lambda > 0, \;\; \bar{r} \equiv \theta r^Y + (1-\theta) r^X \tag{4}$$

$$\dot{\lambda} = \lambda(w^Y - \bar{w}) \equiv \psi(\theta, \lambda), \;\; \psi_\theta > 0, \;\; \psi_\lambda < 0, \;\; \bar{w} \equiv \lambda w^Y + (1-\lambda) w^X \tag{5}$$

where $\bar{r}$ and $\bar{w}$ denote the average rental and wage rates in the economy and the rentals to capital and the wage rates in the two sectors are given by

$$r^i = r^i(\lambda, \theta), \;\; i = X, Y, \;\; r_\lambda^Y > 0, \;\; r_\theta^Y = 0, \;\; r_\lambda^X < 0, \;\; r_\theta^X < 0,$$

$$w^i = w^i(\lambda, \theta), \;\; i = X, Y, \;\; w_\lambda^Y < 0, \;\; w_\theta^Y > 0, \;\; w_\lambda^X > 0, \;\; w_\theta^X < 0, \tag{6}$$

where λ and θ stand for the fraction of labor and capital employed in the "high-tech" sector.[8]

Intuitively, replicator dynamics given by equations (4) and (5) implies that those player types that earn an above (below) average payoff, will have their proportions in the population grow

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[7] The learning dynamics we adopt has the advantage of being formally, but not substantively, similar to the more familiar Marshallian adjustment . The dλ/dt=0 and dθ/dt=0 loci are the same under replicator dynamics as well as Marshallian adjustment, but the transitional dynamics differ under these two. The replicator dynamics have microfoundations as shown later in the text, while Marshallian adjustment is an ad hoc adjustment process. The former has an endogenously determined, variable speed of adjustment, while the latter has an exogenously given, constant speed of adjustment. To see this note that the Marshallian counterparts of (4) and (5) would be given by $\dot{\theta} = \Gamma(r^Y - \bar{r})$ and $\dot{\lambda} = \Delta(w^Y - \bar{w})$ where Γ and Δ are positive constants.

[8] Signs of the partials follow from the assumed neoclassical properties of the production functions.

(decline).[9] In (5), for instance, the rate of growth of the proportion of workers who operate in the "high-tech" sector increases so long as their wage exceeds the economy-wide average wage.[10]

We show in Figure 3 the dynamics of the sectoral allocation of labor and capital under the postulated learning rule. In the figure along the $\dot{\lambda} = 0$ and $\dot{\theta} = 0$ loci wage and rental rates are equalized across sectors. These loci intersect twice yielding two long-run equilibria denoted by points A and B. There exists another equilibrium indicated as point C which corresponds to the full-specialization equilibrium of Figure 2. At points below the $\dot{\lambda} = 0$ locus the wage rate in the low-tech sector exceeds the average wage rate, while at points below the $\dot{\theta} = 0$ locus the rental rate in the high-tech sector is greater than the average rental rate. Thus, of the three equilibria, two, namely A and C, are learning stable, while B is unstable. There is, however, a saddle path, *S*, of Lebesgue measure zero points which leads the economy to point B. This saddle path partitions the set $\Omega = \{(\theta, \lambda) : \theta, \lambda \in [0,1]\} \setminus S$ into two regions, points in which lie on paths that end at stable equilibria A and C.

We can now explore how perturbations to the economy, in the form of changes in the relative price of *X* or in the resource endowments *K* and *L*, affect the economy. Figure 3 shows the effects of an increase in *K*, or decreases in *p* or *L*. Such changes give rise to results that are analogues of the Stolper-Samuelson and Rybczynscki theorems in the present framework. Thus, given our assumption that the high-tech good is capital intensive, starting from an initial stable diversification equilibrium, all of these changes increase the output of the high-tech good and reduce that of the low-tech good. Starting from a B-type equilibrium, the economy ends up at an A-type equilibrium.[11] To put it differently, a small increase in the capital stock or a small change in the terms of trade in favor of the high-tech good can lead to large increases in its production.

Figure 3 also shows the possible existence of cycles in the adjustment process. To see why take the curve emanating from an initial point like J in the figure. This point lies below $d\lambda/dt=0$ and $d\theta/dt=0$

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[9] Alternatively, one can imagine that each player uses a mixed strategy and adjusts the probability mix based on her experience using each pure strategy.

[10] Replicator dynamics can be derived from individual learning behavior. For a discussion of this point see Karayalcin and Mitra (1999).

[11] To see what is involved note, for instance, that for any given allocation of labor (thus λ) an increase in the economy's capital stock K would increase the fraction θ of capital employed in the capital-intensive sector Y, shifting the $d\theta/dt=0$ curve upwards. The same increase in K, for any given allocation of capital θ, would increase the fraction of labor employed in the Y

curves with the implication that at J we have $w^Y<w^X$ and $r^Y>r^X$. Thus, labor starts moving from the high-tech to the low-tech sector and capital does the opposite. More labor in the low-tech sector reduces its marginal productivity and the wage there, while reduced employment in the high-tech sector has the opposite effect on w^Y. Similar results obtain for rental rates in the two sectors. Agents keep moving across sectors as they learn about higher earning opportunities in different sectors. As the figure shows, however, the learning process involves trial-and-error. The movement of labor towards the low-tech sector is reversed since it results in reducing w^X below w^Y . Graphically, the change in direction takes place when the economy hits the $d\lambda/dt=0$ curve, since above this curve $w^Y>w^X$. Tables 1 and 2 illustrate this cyclical adjustment in terms of factor prices by providing a summary of the simulation analysis we carried out for different parameter values. Starting from an arbitrary initial allocation (θ_0, λ_0) and for different levels of the endowments and the relative price of good X, the table indicates whether the factor prices adjust cyclically or not and shows the time period in which the cycles reach their peaks or troughs.[12]

III - Economic Integration

i. Union with Mobile Factors

We now use the framework set up above to study the effects of economic integration that allows free mobility of factors of production across the integrating economies.

The effects of such integration can be most easily seen by letting two identical economies integrate. Thus, take two small open identical economies with the features described above. In the absence of externalities, integration would obviously have no effect on the allocation of resources across sectors. The resultant integrated economy would simply be twice the size of the two previously unintegrated economies. However, if there exist economies of scale as studied above, the doubling of the capital generates an increase in the rate of return to capital in the high-tech sector. As agents learn about the implications of this change, factors of production will be gradually shifted across sectors until

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sector by raising w^Y above w^X, thereby shifting the $d\lambda/dt=0$ curve rightwards. Analogous reasoning can be used to see that a decrease in p or L leads to similar shifts.

[12] The program used to run these simulations can be found at www.fiu.edu/~karayalc/integ.

eventually all arbitrage opportunities are exploited. Figure 4 illustrates the effects of such an integration starting from an initial equilibrium where two identical economies produce both goods. As integration doubles factor endowments both $d\theta/dt=0$ and $d\lambda/dt=0$ curves shift out giving rise to a new stable equilibrium with full specialization in the high-tech good sector.[13] Our simulations show that during this process the GDP of the integrated economy increases above the combined GDP of the non-integrated economies, resulting in a higher value of per capita GDP for the overall population.

A similar exercise can, of course, be conducted starting from different initial conditions. Rather than listing a full taxonomy of different cases that might arise, we will briefly indicate two additional cases of some interest. The first case involves the integration of two diversified economies identical in all respects other than size. The second case arises when the two economies under consideration operate at different points on their PPF's with the consequence that one is fully specialized whereas the other is diversified. In both cases, for reasons similar to those discussed above, the integrated economy will increase its production of the high-tech good and enjoy a higher per capita income.

However, the process of reallocation of factors across sectors initiated by integration is not a smooth and monotonic process. To see what is involved, observe Figure 5 which displays the adjustment paths that arise in simulations for a number of variables of interest. Thus, for instance, we see that integration initially raises the wage rate in the low-tech sector which attracts labor away from the high-tech sector. As a result the latter sector experiences rising wages and falling rentals. As agents learn about the new environment, labor gradually moves away from the low-tech sector with the consequence that the previous phase of the cycle in terms of returns to factors in the high-tech sector is reversed. The rest of the transient phase is characterized by a movement of both factors into the latter sector.

The benefits of economic integration in the presence of externalities is evidenced by the rise of the GDP in the integrated economy to levels significantly higher than the combined GDP's of the unintegrated economies. Note that the integrated economy's GDP continues to rise throughout the

[13] Note that, as shown in Figure 4, the dotted $d\lambda/dt=0$ and $d\theta/dt=0$ curves need not intersect at $\theta=\lambda=1$, since at this point, where the economy fully specializes in the high-tech good, this sector may indeed pay higher rentals and wages.

transition up until resources find their most efficient allocation after going through a gradual leaning process.[14]

ii. A Free Trade Area with Rules of Origin

The second case of economic integration we consider is that of the formation of a free trade area (FTA) by two small countries each of which has the features studied above.

We first assume that rules of origin are applied. This is realistic as most current FTAs typically impose such a condition that prevents the within-FTA resale of commodities imported from the ROW free of duty. Thus this FTA is such that goods produced within it are allowed to move between the countries free of duty.

To fix ideas consider two small countries labeled H (home) and F (foreign) each of which can produce the two goods Y (high-tech) and X (low tech), the production functions of which are given in (1) and (2). Normalize the world price of each of the goods to 1 by an appropriate choice of units. Country H (F) imposes a tariff t^i (T^i) (i=X,Y) on the good that it imports. Assume for the sake of the argument that $t^i > T^i$.

After the formation of the FTA, countries continue to import whichever good they were importing from the rest of the world (ROW). Both before and after the formation of the FTA each country produces both goods.

The consequences of the formation of a FTA depends on the trade patterns that arise. Below we study two possible cases and leave the analysis of others to the interested reader.[15]

a. Both H and F import good Y and export good X.

Since H continues to import Y from the ROW by assumption, the consumer price of the good Y in the FTA equilibrium is the same as before: $p^Y=1+t^Y$. Because the good can be imported into F at

[14] An interesting case that could be similarly analyzed is suggested by the European Union where cultural and linguistic differences prove to be formidable barriers to labor mobility while capital moves freely within the Union. To analyze this case we shall focus on one possible initial configuration and encourage the reader to analyze others analogously. Suppose that two countries that find themselves at points A and D in Figure 3 form an economic union within which labor is immobile, while capital moves freely. Since the union member that finds itself initially at point D has a higher return to capital [$r=\alpha(\lambda L)^{1-\alpha}$] relative to the other country, capital will flow into the D-country from the A-country. This inflow of capital into the D-country will, as before, expand the production of the high-tech Y good there at the expense of the low-tech X good. The A-country will experience just the opposite effects as capital flows out. Thus, the new long-run equilibrium will be such that the country that started out with a larger high-tech sector will end up with an even larger one and vice versa.

$1+T^Y < 1+t^Y$, the consumer price of the good in F cannot rise above $1+T^Y$. It then follows that all of good Y produced in F will be sold in H, the demand in F for Y being satisfied by imports from the ROW. Thus, the FTA does not lead to any change in consumer prices.

The producer price of Y for H producers is unaffected by the formation of the FTA. But since the producers of Y in F sell all their goods in H at a price $1+t^Y > 1+T^Y$, the producer price of good Y for H producers is higher in the FTA equilibrium. Thus, integration in the form of a formation of an FTA does not affect H, while leading to an decrease in the relative price of X for its producers in F. Thus Figure 3 and Tables 1 and 2 can again be used to study the consequences of integration for country F where the output of the high-tech good expands.

b. H imports good Y and exports good X. F imports good X and exports good Y.

Since H continues to import Y from the ROW by assumption, the consumer price of the good Y in the FTA equilibrium is the same as before: $p^Y=1+ t^Y$. All of good Y produced in F will be sold in H. Since the producers of Y in F sell all their goods in H at a price $p^Y=1+ t^Y >1$ (as do those in H as before the FTA), the producer price of good Y for F producers is higher. The producer price of Y for H producers is unaffected by the formation of the FTA. Again, the consequences of the formation of the FTA for economy F would be depicted by Figure 3 and Tables 1 and 2.

Since F continues to import X from the ROW by assumption, the consumer price of the good X in the FTA equilibrium is the same as before: $p^X=1+ T^X$. All of good X produced in H will be sold in F. Since the producers of X in H sell all their goods in F at a price $1+ T^X >1$ (as do those in F as before the FTA), the producer price of good X for H producers will be higher in the post-FTA equilibrium, leading to an expansion of its output. The producer price of X for F producers is unaffected by the formation of the FTA.

The general principle that emerges from the discussion of these two cases is that consumers in each country face the same prices before and after the formation of the FTA. However, for the good imported by both countries before the FTA, the formation of the union results in all producers facing the consumer price in the country with the higher tariff.

[15] The analysis below is based on Panagariya (2003).

iii. An FTA without Rules of Origin

Rules of origin are sometimes avoided because of high costs of enforcement. As pointed out by Krishna (2003) and McGillivray (2000) (and originally mentioned in Viner (1950)), America, right after the colonies obtained independence from the British, became a free trade area (FTA) *without rules of origin*. During the period of the Articles of Confederation (1777-1789), the thirteen original American states traded freely among themselves but each set its external tariffs independently. British merchants, therefore, landed in the ports with the lowest tariffs.[16] However, over time, competition among states to extract tariff revenues resulted in a race to the bottom in the setting of tariffs, thereby leading to virtually non-existent external tariffs. Thus, in the context of our framework, an FTA formed by two small open economies without rules of origin will experience a reduction of the effective external tariff to the lower of the tariffs in the two countries.

If countries H and F form an FTA without rules of origin and if both countries import the same good, say good Y, from the rest of the world with official import tariffs of t^Y and T^Y (which were no different prior to FTA formation) respectively such that $t^Y > T^Y$, then effective external tariff in both countries will be T^Y. Normalizing the world relative price of the goods to unity as above, forming an FTA without rules of origin would imply a reduction in the domestic relative price of the importable in H from $(1 + t^Y)$ to $(1 + T^Y)$ which means that the relative price of X rises. The domestic relative price in country F remains unchanged. Thus we can study this using figure 3 which clearly shows an expansion in the output of X and a reduction in Y in H if it had been at the high-tech equilibrium to begin with.[17] During the transition period labor and capital will flow into the high-tech sector.

The situation in which the two countries do not initially export and import the same goods (eg, one exports (imports) X (Y) and the other Y (X)) from the rest of the world is more complicated. If the external tariffs are good-specific and they remain the same after the formation of the FTA, then imports of the free trade area will enter the port of the country that was an exporter of the good prior to the formation of the FTA. Thus, the effective relative price in the FTA now equals the world relative price which is unity by assumption. This kind of an FTA then results in free trade with each other as well as

[16] This situation is equivalent to having a customs union with a common external tariff equal to the minimum of the external tariffs of the FTA members.

the rest of the world. Thus, the comparative statics and dynamics boil down to changing the relative price, this time in both countries. However, if external tariffs are not good specific but are applied uniformly to all goods entering the country from abroad, then imports of the FTA enter the country with the lower tariff.[18]

IV - Break-up of an Economic Union

What would be the consequences of a breaking up of an existing economic union? We address this question now in the context of the disintegration of the economic union such that a previous member leaves the union and factor mobility across the component parts is abolished. We still maintain, however, the assumption that all economies considered are small relative to the rest of the world and open to trade in goods.

Within the framework we have established earlier, two plausible scenarios can be immediately constructed. In the first one, prior to the break-up the production in the union is diversified. The second scenario contemplates a union that specializes in the production of the high-tech good. In both cases, we study the effects of a break away of a small component part from the union. In this we are motivated by real world examples of, say, small Caucasian republics of Russia or the contemplated secession of Quebec from Canada.

Our simulations of both scenarios highlight the result that the small break-away economy ends up specializing in the low-tech sector, whereas the remaining part of the union produces both goods (see Figure 6). Given our previous analysis of integration, one significant negative consequence of such disintegration would, of course, come as no surprise: income per capita of both the economies remaining in the union and the break-away economy decline. Intuitively, this result is the consequence of the presence of externalities. As the sizes of the economies in question decline, the benefits from spillovers are partially lost. Furthermore, as in the previous section the adjustment path is characterized by cycles in rates of return to factors. Again, the break-up confronts agents with a new environment and

[17] If initially H was at the unstable equilibrium, it will end up specializing in X.

[18] Our analysis can easily be extended to a customs union--a FTA with a common external tariff and where, therefore, rules of origin are not needed. The domestic price and the world price will thus have a wedge determined by this common tariff. Thus again, one can easily perform comparative static and dynamic exercises as before.

the gradual learning about this environment and the consequent reallocation of factors across sectors is far from being a smooth process.

V – Conclusion

We have studied above the consequences of both forming an economic union (in the sense of eliminating barriers to the international movement of both goods and factors of production) and the breaking up of an existing union. Our framework has highlighted two aspects of the background to these processes. First, we have focused on an environment in which there exist input-generated external economies with the consequence that the decentralized outcomes are inefficient: the social PPF differs from the private one and the private marginal rate of transformation fails to coincide with relative good prices. Furthermore, the externalities under question generate multiple equilibria. Second, we have taken seriously the challenges that private agents face when (dis)integration alters the environment in which they operate. To formalize the process by which agents adapt to their environment and to solve the equilibrium selection problem that the presence of externalities present we have made use of a simple learning rule that can be derived from first principles.

Our results show that an economic union even between identical economies can generate higher per-capita incomes by expanding the scale over which externalities operate. Forming a union may change the product mix such that economies that used to specialize in low-tech goods may switch to the production of high-tech goods and take advantage of spillovers. Conversely, breaking up of an existing union is costly for both the economies remaining in the union and those that break away. Such a move lowers incomes per capita and as a consequence of the loss of benefits from spillovers may condemn the break-away economies to specialization in the low-tech sector. Furthermore, we have shown that as a result of learning dynamics adjustment paths may be cyclical as factors move away from sectors with low rates of return.

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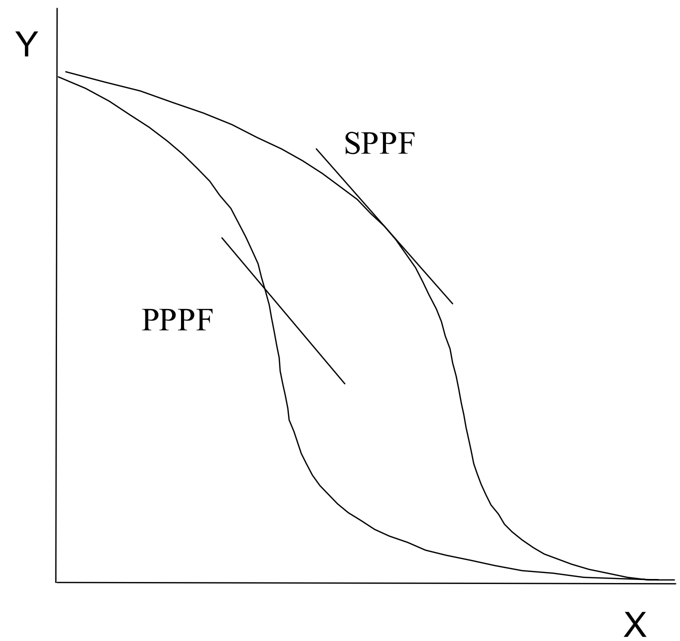

Figure 1

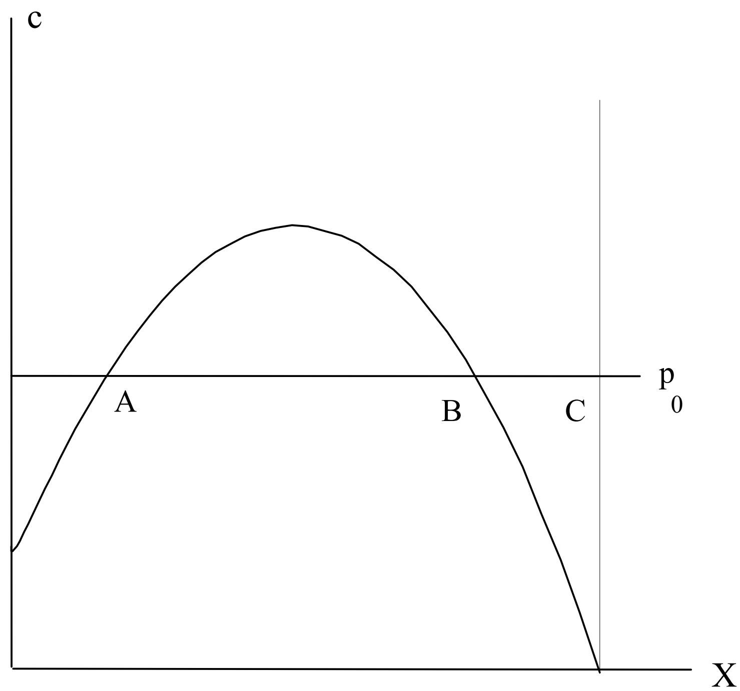

Figure 2

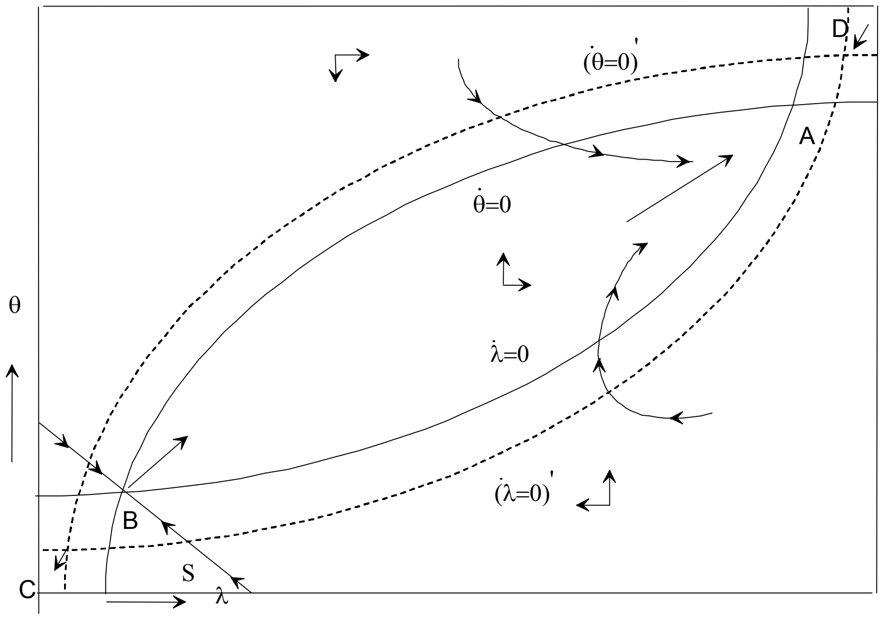

Figure 3

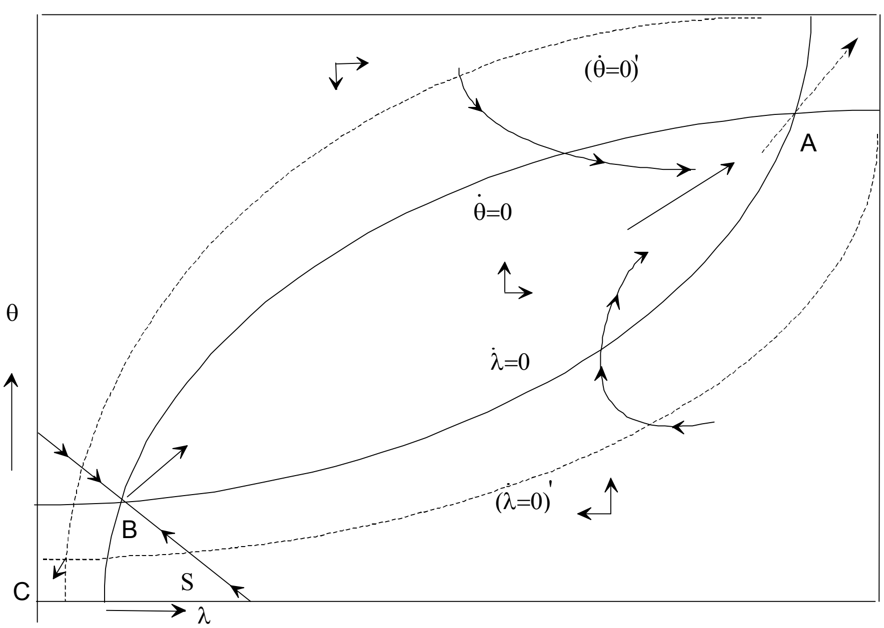

Figure 4

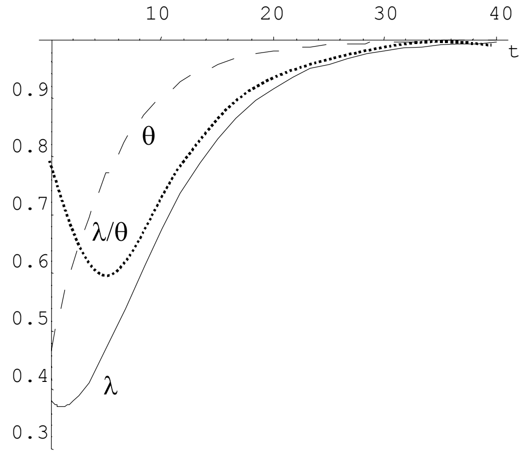

Figure 5.1

Allocation of labor and capital to the high-tech sector

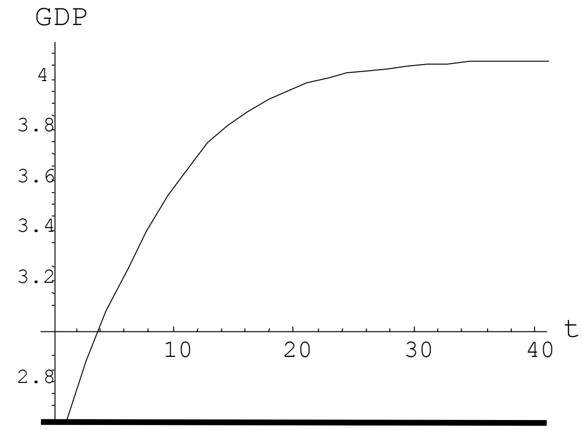

Figure 5.2

Value of GDP in the integrated economy (horizontal line represents the combined GDP of member countries at the moment of integration)

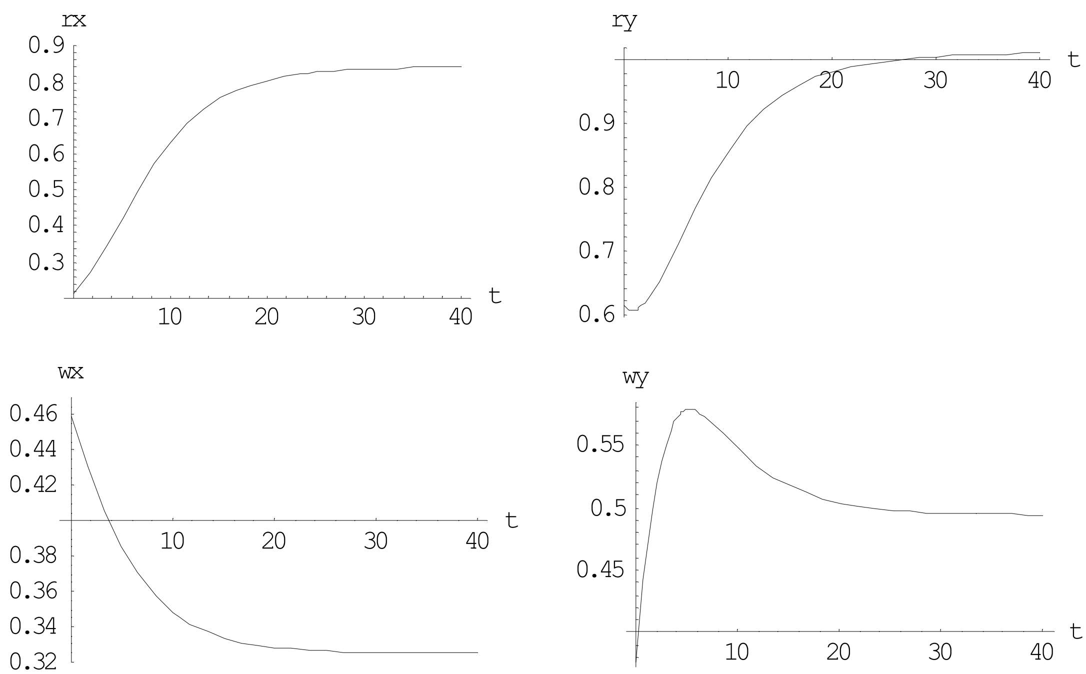

Figure 5.3

Evolution of capital rental rates (r_i) and wages (w_i) in sectors X and Y after integration.

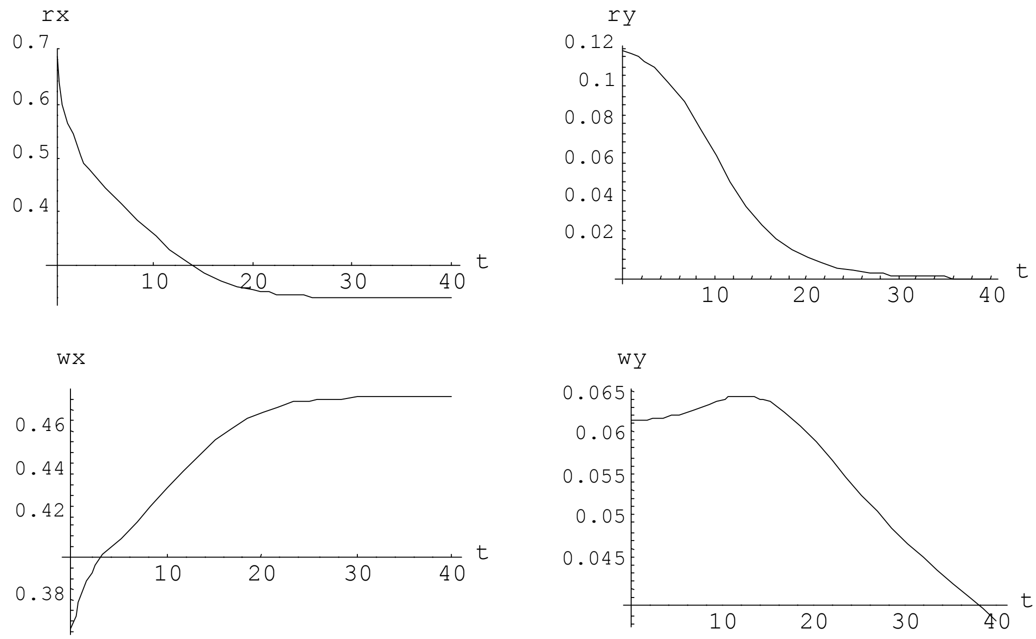

Figure 6.1

Evolution of capital rental rates (r_i) and wages (w_i) in sectors X and Y after break-up.

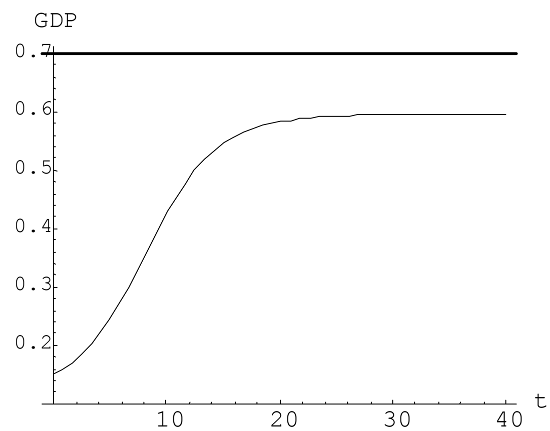

Figure 6.2

Value of GDP per capita in the small break-away economy
(horizontal line represents the GDP per capita of the union before the break-up)

TABLE I:
Simulation with K=1 and L=1.

Relative Price of Good X	Factor Shares at t=0		Capital Rental Rates		Labor Wages		Factor Shares at t=end	
P	θ_0	λ_0	r_x	r_y	w_x	w_y	θ_{end}	λ_{end}
P = 0.85	0.9	0.1	none	t = 10 (peak)	none	t = 18 (trough) t = 42 (peak)	0	0
	0.7	0.3	none	t = 5 (peak)	none	none	0	0
	0.5	0.5	t = 9 (peak)	none	t = 9 (peak)	t = 15 (peak)	0	0
	0.3	0.7	t = 9 (peak)	none	t = 9 (trough)	t = 14 (peak)	0	0
	0.1	0.9	t = 10 (peak)	none	t = 10 (trough)	t = 15 (peak)	0	0
P = 0.84	0.9	0.1	none	t = 13 (peak)	none	t = 21 (trough) t = 90 (peak)	0	0
	0.7	0.3	none	t = 6 (peak)	none	t = 35 (peak)	0	0
	0.5	0.5	t = 12 (peak)	none	t = 16 (trough)	t = 31 (peak)	0	0
	0.3	0.7	t = 10 (peak)	none	t = 10 (trough)	t = 15 (peak)	0	0
	0.1	0.9	t = 10 (peak)	none	t = 10 (trough)	t = 15 (peak)	0	0
P = 0.83	0.9	0.1	t = 14 (trough)	none	t = 14 (peak)	none	1	1
	0.7	0.3	t = 15 (trough)	none	t = 15 (peak)	none	1	1
	0.5	0.5	t = 12 (peak)	none	t = 12 (trough)	t = 21 (peak)	0	0
	0.3	0.7	t = 11 (peak)	none	t = 11 (trough)	t = 15 (peak)	0	0
	0.1	0.9	t = 11 (peak)	none	t = 11 (trough)	t = 15 (peak)	0	0
P = 0.82	0.9	0.1	t = 12 (trough)	none	t = 12 (peak)	none	1	1
	0.7	0.3	t = 8 (trough)	none	t = 8 (peak)	none	1	1
	0.5	0.5	t = 17 (peak)	none	t = 16 (trough)	t = 23 (peak)	0	0
	0.3	0.7	t = 11 (peak)	none	t = 12 (trough)	t = 17 (peak)	0	0
	0.1	0.9	t = 11 (peak)	none	t = 11 (trough)	t = 15 (peak)	0	0
P = 0.81	0.9	0.1	t = 11 (trough)	none	t = 11 (peak)	none	1	1
	0.7	0.3	t = 7 (trough)	none	t = 7 (peak)	none	1	1
	0.5	0.5	none	t = 10 (trough)	none	t = 20 (peak)	1	1
	0.3	0.7	t = 13 (peak)	none	t = 13 (trough)	t = 19 (peak)	0	0
	0.1	0.9	t = 11 (peak)	none	t = 11 (trough)	t = 15 (peak)	0	0

α = 0.5
β = 0.2

TABLE II:
Simulation with K=2 and L=2.

Relative Price of Good X	Factor Shares at t=0		Capital Rental Rates		Labor Wages		Factor Shares at t=end	
P	θ_0	λ_0	r_x	r_y	w_x	w_y	θ_{end}	λ_{end}
P = 0.85	0.9	0.1	t = 5 (trough)	none	t = 5 (peak)	none	1	1
	0.7	0.3	t = 2 (trough)	none	t = 2 (peak)	none	1	1
	0.5	0.5	none	t = 2 (trough)	none	t = 7 (peak)	1	1
	0.3	0.7	none	t = 4 (trough)	none	t = 9 (peak)	1	1
	0.1	0.9	none	t = 6 (trough)	none	t = 12 (peak)	1	1
P = 0.84	0.9	0.1	t = 5 (trough)	none	t = 5 (peak)	none	1	1
	0.7	0.3	t = 2 (trough)	none	t = 2 (peak)	none	1	1
	0.5	0.5	none	t = 2 (trough)	none	t = 7 (peak)	1	1
	0.3	0.7	none	t = 4 (trough)	none	t = 9 (peak)	1	1
	0.1	0.9	none	t = 6 (trough)	none	t = 12 (peak)	1	1
P = 0.83	0.9	0.1	t = 5 (trough)	none	t = 5 (peak)	none	1	1
	0.7	0.3	t = 2 (trough)	none	t = 2 (peak)	none	1	1
	0.5	0.5	none	t = 2 (trough)	none	t = 7 (peak)	1	1
	0.3	0.7	none	t = 4 (trough)	none	t = 9 (peak)	1	1
	0.1	0.9	none	t = 6 (trough)	none	t = 12 (peak)	1	1
P = 0.82	0.9	0.1	t = 5 (trough)	none	t = 5 (peak)	none	1	1
	0.7	0.3	t = 2 (trough)	none	t = 2 (peak)	none	1	1
	0.5	0.5	none	t = 2 (trough)	none	t = 7 (peak)	1	1
	0.3	0.7	none	t = 4 (trough)	none	t = 9 (peak)	1	1
	0.1	0.9	none	t = 6 (trough)	none	t = 12 (peak)	1	1
P = 0.81	0.9	0.1	t = 5 (trough)	none	t = 5 (peak)	none	1	1
	0.7	0.3	t = 2 (trough)	none	t = 2 (peak)	none	1	1
	0.5	0.5	none	t = 2 (trough)	none	t = 7 (peak)	1	1
	0.3	0.7	none	t = 4 (trough)	none	t = 9 (peak)	1	1
	0.1	0.9	none	t = 6 (trough)	none	t = 12 (peak)	1	1

α = 0.5
β = 0.2