Aspects of International Fragmentation

by

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to be presented at the conference

"Adjusting to Globalisation"

28th to 29th June 2002
The Leverhulme Centre for Research on
Globalisation and Economic Policy (GEP)
University of Nottingham

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1 Introduction

Globalization means different things to different people. To some, it means welcome opportunities, to others it holds the spectre of painful adjustment and a general sense of being at the losing end. In addition to individuals, governments are often worried by the unpleasant feeling of losing national policy autonomy in a world where all markets are global. No wonder, therefore, that economic globalization is sometimes felt more like a threat than a beneficial development and adjusting to globalization is perceived as a key policy challenge of the time.

Any well-guided policy of adjusting to globalization, however, requires an explicit definition of what we mean by globalization. Following Peter Temin (1999), I submit that a defining feature of economic globalization is the world-wide dominance of arbitrage on markets for goods, factors, and financial assets. Arbitrage implies a tendency to equalize prices of goods and factors, as well as (risk-adjusted) returns on assets across national boundaries. Temin points out that economic globalization, defined in this way, was characteristic already of the late 19th century, albeit without appearance of the term globalization. It has therefore become common to refer to the late 20th / early 21st century as the second wave of economic globalization.

Is there anything special about the second wave? According to the traditional view of international economics, there are three principal channels through which internationalization takes place: international exchange of commodities, international mobility of financial capital (assets and savings), and international migration. There is widespread consensus that in all of these dimensions the first wave of economic globalization more than 100 years ago was no less pronounced than the second.[1] Indeed, the general perception is that although there is an ever higher degree of international commodity market integration, labor markets are still quite national, because of either natural barriers to migration or migration policies; see for instance Faini (1999). And regarding financial capital, although there is a close to perfect integration of asset markets, international mobility of savings is actually rather limited if judged by the degree of independence between

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[1]In addition to Temin (1999), see Irwin (1996), Williamson (1996), Obstfeld (1998), and O'Rourke & Williamson (1999).

national investment and national savings rates.[2]

What, then, is the distinctive feature of the second wave of economic globalization that would warrant the degree of apprehension that we observe today? A possible response is to point out new vehicles of internationalization regarding commodity and factor markets. The traditional view of internationalization rests on a clear distinction between produced commodities and primary factors. The principle of international arbitrage is seen as operating on goods prices directly via international exchange of goods, based on a given and well defined underlying value-added process. In addition, it operates on factor prices – directly via international factor movements, and indirectly via the factor price effects of trade. More recently, however, this view appears at odds with facts. Certain developments that are generally associated with economic globalization, and which have to do with improvements in communications technology as well as abolition of formal barriers, have caused the principle of international arbitrage to cut into ever smaller slices of what was formerly perceived as a coherent value-added process. This blurs the distinction between commodity markets and trade on the one hand, and factor movements on the other. What we observe, then, is an international fragmentation of value-added processes which were hitherto carried out in an integrated way within certain countries. One might argue that this has fundamentally changed the world economy, and that it justifies the notion of a *new form* of economic globalization. Sometimes international fragmentation may arise in a pretty fearsome way in that countries all of a sudden lose whole components of value-added chains in certain industries which are perceived as cornerstones of certain regions within the domestic economy. Obviously, adjusting to such forms of globalization, if they occur, is a formidable challenge to economic policy.

This new form of economic globalization has come to be known not only as fragmentation, but also as outsourcing, international disintegration of production, or vertical specialization. These terms are sometimes defined differently, but I shall use them inter-

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[2]This is the well-known Feldstein-Horioka puzzle; see Feldstein & Horioka (1980). In the light of more recent evidence, this "independence-result" should be interpreted with care; see the discussion in Obstfeld & Rogoff (1998, pp.161-163). However, the point I want to emphasize here is that one should separate two distinct issues. One is international integration of markets for financial assets, usually measured by the degree to which the interest rate parity condition is met, the other is the degree to which investment in physical capital in any one country relies on domestic or foreign savings. There is widespread agreement that the capital mobility in this later sense is lower than in the former.

changeably in this paper. There is a sizable body of literature demonstrating the empirical significance of international fragmentation and outsourcing in the recent episode of economic globalization.[3] I shall take the empirical importance for granted and abstain from dealing with empirical issues in this paper. What I intend to do, instead, is to provide a framework of analysis which may help forming a well-guided policy of adjustment if some region is faced with the spectre of losing whole components of certain industrial value-added processes, due to international fragmentation. The general presumption is that there will be a temptation on the part of policy makers to "do something about it", particularly with respect to local labor markets. What are the important questions to ask? What are the criteria that policy makers should employ?

Some basic points are easily identified. If labor that is released due to outsourcing were to remain permanently unemployed, then there would be a clear case for a defensive policy stance, trying in one way or another to prevent or restrict outsourcing. However, whether or not unemployment caused by outsourcing will be permanent is not exogenous to policy. Hence this is a highly questionable assumption to rely upon for policy formation. But even for relatively rigid labor markets, assuming job losses to be permanent is no doubt a highly unrealistic assumption. The relevant question to ask is whether, under the given labor market institutions, alternative employment of the resources set free through outsourcing generates value-added which is sufficient for the economy (or region) as a whole to gain from this form of globalization. The question may be turned upside down, asking if there is a potential for welfare loss even under well-functioning labor markets, justifying a defensive policy reaction from an efficiency point of view. And, of course, there may always be a case for such a policy based on distributional concerns. Hence, what we need is a framework of analysis which allows us to juxtapose the efficiency (or welfare) aspects and the distributional aspects of international fragmentation.

The framework that I suggest in this paper is based on the well-known specific factors model pioneered by Jones (1971). I try to make the analysis as simple as possible, given the purpose outlined above. A key assumption is dimensional in nature: Fragmentation is exogenously restricted to one of only two sectors. Each of these sectors produces a tradable *final* good, using mobile labor and a specific factor, called capital. A further

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[3]For empirical studies, see Irwin (1996), Feenstra & Hanson (1996, 1997, 1999), Feenstra (1998), Hummels et al. (1998, 2001), and several papers in Arndt & Kierzkowski (eds., 2001).

assumption relates to the cope of explanation: I do not explain the details of why outsourcing takes place, and I assume that it will not affect world prices of the two final goods considered. Within these confines, I will show that if outsourcing takes place without any element of indivisibility (or non-convexity) in production, then it will cause an efficiency gain which is perfectly analogous to the so-called immigration surplus of inward migration. Moreover, the distributional implications of fragmentation are similarly analogous to inward migration. I will then show that the presence of indivisibilities (non-convexities) may cause outsourcing to be welfare reducing. Such non-convexities will require some additional modeling relating to the deviation from perfect competition. I shall identify the crucial conditions responsible for whether or not the negative welfare result obtains. Finally, I shall consider the welfare implications of outsourcing if there is monopsony power on the domestic labor market, which may or may not be related to non-convexities in production. For reasons of space, I will not deal with the question of optimal policies to deal with these welfare implications.

2   A basic model of international fragmentation

The extent to which a certain value-added process is amenable to fragmentation is determined by technology; the extent to which it actually takes place across international borders is governed by economic considerations. In one way or another, scenarios of increasing fragmentation involve a) some form of technological advancement, facilitating an easier linkage of individual value-added components carried out in different locations,[4] and b), a reduction in formal and technical barriers to trade (trade liberalization). However, for globalization to involve a significant increase of international fragmentation, a) and/or b) are not enough. There must at the same time be a cost-advantage from international fragmentation, such as international factor price differences, which is not annihilated by other forms of globalization, say trade in final goods and/or factor movements.

This paper does not attempt to explain why and where outsourcing happens. Instead, outsourcing is taken as an exogenous event and the focus of interest lies on its effect on welfare and domestic income distribution. The approach that I choose runs as follows. The

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[4]See Jones & Kierzkowski (1990, 2001a, 2001b).

principal possibility of international fragmentation is captured by a suitable description of technology, assuming that production may be disintegrated in sector 1, while it is always fully integrated in sector 2. I start out by looking at an equilibrium for a single economy (region) facing given final goods prices, where international fragmentation – although possible in principle – does not arise. I then invoke a nearby country with a lower wage rate for an effective unit of labor, assuming that due to some exogenous reduction in the cost of international fragmentation firms face an incentive to engage in international fragmentation, exploiting the lower foreign wage rate by carrying out one of the two fragments of value added abroad. This gives rise to a new domestic equilibrium, depending in detail on the precise circumstances under which such outsourcing takes place. A comparative static analysis of the two equilibria then allows me to address the welfare and distributional aspects of international fragmentation.

To start out, the model requires little more than specifying the production side of the economy.[5] Indicating the two sectors by superscript indices 1 and 2, and the two fragments of value-added by subscripts, final outputs Y^1 and Y^2 must satisfy the following two production functions and a full employment constraint:

$$Y^1 \;=\; Y^1 \left[F_2^1(L_1^1, \bar{K}_1^1), F_2^1(L_2^1, \bar{K}_2^1) \right] \tag{1}$$

$$Y^2 \;=\; Y^2(L^2, \bar{K}^2) \tag{2}$$

$$\bar{L} \;=\; L_1^1 + L_2^1 + L^2 \tag{3}$$

Throughout the analysis, total labor endowment is given at $\bar{L}$ and assumed to be fully employed. All capital stocks $\bar{K}$ are given and sector-specific. For industry 1, they are also specific to the two fragments which are modeled by separable sub-production functions F_2^1 and F_2^1, respectively. To start with, I assume that all production functions are concave and there is perfect competition on goods and labor markets. Alternative technologies incorporating non-convexities and elements of imperfect competition will be considered in later stages. I assume a given number of domestic firms in both sectors that face given world prices for the two final goods. For ease of notation, I assume the relative price of the two goods to be equal to 1.

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[5]The underlying technology here is similar to that in Kohler (2001), but I explore a different and somewhat richer set of conditions under which outsourcing takes place.

Using w to denote the domestic wage rate, the first-order conditions for profit maximization are

$$w = Y_j^1 \left[F_1^1(L_1^1, \bar{K}_1^1), F_2^1(L_2^1, \bar{K}_2^1) \right] \times F_{jL}^1(L_1^1, \bar{K}_1^1) \quad j = 1, 2 \tag{4}$$

$$w = Y_L^2(L^2, \bar{K}^2) \tag{5}$$

where Y_j^1 denotes the marginal productivity of fragment j in sector 1, and F_{jL}^1 denotes the marginal productivity of labor in generating fragment j of industry 1. As disintegration of production in sector 2 is ruled out by assumption, Y_L^2 denotes the marginal productivity of labor in industry 2. The two conditions 4 can be solved to yield two labor demand curves $V_1^1(w, \bar{K}_1^1, \bar{K}_2^1)$ and $V_2^1(w, \bar{K}_1^1, \bar{K}_2^1)$. Adding the corresponding labor demand curve for industry 2 from condition 5, $V^2(w, \bar{K}^2)$, we obtain the equilibrium wage rate w^* from

$$\bar{L} = V_1^1(w, \bar{K}_1^1, \bar{K}_2^1) + V_2^1(w, \bar{K}_1^1, \bar{K}_2^1) + V^2(w, \bar{K}^2) \tag{6}$$

I shall henceforth write $V^1(w, \bar{K}_1^1, \bar{K}_2^1) = V_1^1(w, \bar{K}_1^1, \bar{K}_2^1) + V_2^1(w, \bar{K}_1^1, \bar{K}_2^1)$ for overall labor demand by industry 1 *under integrated production*. Integrated production means that a single wage rate is relevant for production of both fragments. Inserting w^* back into the first order conditions, we obtain equilibrium employment levels $L^{1*} = L_1^{1*} + L_2^{1*}$ and $L^{2*} = \bar{L} - L^{1*}$.

The situation is depicted in the usual way by figure 1. Separability of production in sector 1, which will subsequently be responsible for international fragmentation, can be brought to the fore by drawing V_2^1 with its origin placed at L_1^{1*}. Then equilibrium value added in industry 1 can equivalently be measured by the area $A^1 B L^{1*} 0^1$ and by the sum of area $A_1^1 B_1^1 L_1^{1*} 0^1$ (value generated by fragment 1) plus area $A_2^1 B L^{1*} L_1^{1*}$ (value generated by fragment 2). The equilibrium output value in industry 2 is given by the area $A^2 B L^{1*} 0^2$. It should be borne in mind that both marginal value added schedules V_j^1 are determined by fragment-specific capital stocks. More importantly, each of the two areas $A_2^1 B L^{1*} L_1^{1*}$ and $A^1 B_1^1 L_1^{1*} 0^1$ represents "derived" value-added, subject to the other fragment being available in the required (optimal) amount.

Suppose now that there is a neighboring country, say in eastern Europe if the domestic economy is an EU incumbent, with a wage rate w^E. Notice that w^E is the wage rate for an *effective* unit of labor, comparable to domestic labor employed under integrated production. An effective unit of foreign labor may require more than one natural unit for two reasons: there may be costs of disintegrating production across borders, and

there may be a pure efficiency difference between the two regions.[6] We assume that, due to technological improvements (either reducing the costs of disintegration or increasing the level of foreign efficiency) w^E now falls below w^*. This is our simple "globalization scenario".[7] Moreover, we assume that for technical reasons outsourcing is restricted to fragment 2. Throughout this paper, I assume that w^E is not affected by outsourcing.[8]

We must now make a distinction regarding the nature of international fragmentation. One may think of outsourcing as relying on *arms-length transactions* between domestic firms and foreign sub-contractors. This implies that the required capital stock as well as the technology $F_2^1(L_2^1, \bar{K}_2^1)$ is available to foreign firms. If this is the case, then foreign firms can produce a fragment of industry 1 value added which is worth $A_2^1 B L^{1*} L_1^{1*}$ to domestic firms at a cost which is lower than this value by an amount measured by the area $B_1^1 BDC$ in figure 1. It may then be a question of bargaining power to what extent domestic firms can appropriate the cost-advantage from foreign production of fragment 2 for themselves. In principle, however, one could also envisage a case where neither domestic firms nor foreign sub-contractors have any market power at all. In any case, pursuing along these lines would require explicit modeling of the foreign economy, beyond referring to its wage rate alone. In some cases, however, proceeding with a given and unchanged foreign w^E may seem quite realistic. For instance, as in the well-known OLI-paradigm of multinational firms, there may be certain intangible assets which confer an ownership-advantage to domestic firms, putting them in a position to obtain the initial amount of fragment 2, representing (to them) a value of $A_2^1 B L^{1*} L_1^{1*}$ at a cost equal to $A_2^1 B B_1^1$ (on-going capital-rental to foreign capital) plus $CDL^{1*} L_1^{1*}$ (foreign labor cost). In this case they can fully appropriate the cost-advantage $B_1^1 BDC$.

A different – and probably more satisfactory – interpretation assumes that, instead

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[6] See also Kohler (2001). This assumes that costs of disintegration act like iceberg-cost on labor alone, and that technological differences are of a Harrod-neutral form. These are restrictions, of course, but they seem warranted by the simplicity of exposition gained at this stage.

[7] I ignore artifical, or formal, barrier to trade which may similarly be responsible for an outsourcing-incentive to arise. A scenario with special relevance is one where in an environment of preferential trade agreements rules of origin may be applied with more general cumulation. This will, for instance, be the case for eastern European countries once they become members of the EU.

[8] In Kohler (2001) I also explore the case where domestic firms face an upward-sloping foreign labor supply curve.

of relying on arms-length transactions with subcontractors, domestic firms engage in *foreign direct investment* to exploit the cost-advantage on producing fragment 2 abroad. In doing so, they rely on their own capital to produce F_2^1, using foreign labor at a constant wage rate w^E, instead of domestic labor. To keep matters simple, I assume that the *total* stock invested at home and abroad is equal to $\bar{K}_2^1$. If production of both fragments, F_1^1 and F_2^1 were kept at their original levels, then international fragmentation could be described as $F_2^1(L_2^{1*}, \bar{K}_2^1)$ being shipped to (parent) domestic firms at a transfer price $A_2^1 BB_1^1 + CDL^{1*}L_1^{1*}$, with the cost-advantage $B_1^1 BDC$ accruing to domestic capital owners. This does not, however, tell us much about the welfare effect, because it could be a mere re-distribution from labor to capital income. To know more about the welfare and distribution effects of such outsourcing, we must look at the full new equilibrium that will emerge with $w^E < w^*$, given the possibility of locating production of fragment 2 abroad. It will become clear immediately that with a flexible domestic wage rate, total production levels of the two fragments (domestic and foreign) will not remain unchanged. Indeed, the precise nature of quantity adjustments to disintegration of fragment 2, and the associated reallocation of domestic labor, importantly drives the overall efficiency effect which will not be positive under all conceivable circumstances.

3   "Outsourcing-surplus" from fragmentation

The policy attitude towards outsourcing should reflect a well-balanced consideration of both, overall welfare effects and distributional consequences. Figure 1 provides a convenient starting point for an identification of the crucial channels involved in both regards. In switching from domestic to foreign procurement of fragment 2, firms in industry 1 shed domestic labor in the amount of $L^{1*} - L_1^{1*}$. The policy maker will surely worry about what happens to this labor. The economist will respond to this concern by pointing out that the overall welfare effect of this scenario depends on whether domestic labor released through outsourcing finds alternative employment where it generates an output value equal to that of its previous use. Specifically, the immediate cost-savings effect $CB_1^1 BD$ will show up as an overall welfare gain for the home economy at large if all of domestic labor finds alternative use where it creates value added equal to its former income, measured by the rectangle $(L^{1*} - L_1^{1*}) \times w^*$. However, to the extent that this alternative value added is lower than $(L^{1*} - L_1^{1*}) \times w^*$, the immediate welfare gain is reduced or may vanish alto-

gether. Indeed, the gain may even turn to a welfare loss if this value added is sufficiently low. To see if it does we need to solve for the new "fragmentation equilibrium".

The subsequent analysis will show that outsourcing has a positive welfare effect if the following two conditions are met: 1) there are no market imperfections, and 2) outsourcing is a continuous process and not subject to any indivisibility. An obvious violation of condition 1) is the case in which all domestic labor set free through outsourcing remains unemployed, due to a downward rigidity of the wage rate. I shall not dwell on this case any further, but pursue less obvious cases instead. Specifically, I shall concentrate on lack of divisibility below, after establishing a general welfare result for the case where no indivisibility (or non-convexity), whatsoever, is involved.

To be more precise, by no indivisibility I mean that there is no fixed cost, either in production as such, or in linking fragments produced in different locations (costs of international fragmentation). In this case, the new equilibrium is described by

$$w = Y_1^1 \left[F_1^1(L_1^1, \bar{K}_1^1), F_2^1(L_2^1, \bar{K}_2^1) \right] \times F_{1L}^1(L_1^1, \bar{K}_1^1) \tag{7}$$

$$w^E = Y_2^1 \left[F_1^1(L_1^1, \bar{K}_1^1), F_2^1(L_2^1, \bar{K}_2^1) \right] \times F_{2L}^1(L_2^1, \bar{K}_1^1) \tag{8}$$

$$w = Y_L^2(L^2, \bar{K}^2) \tag{9}$$

$$L_{2f}^1 = L_2^1 - (\bar{L} - L^2 - L_1^1) \tag{10}$$

$$w \geq w^E \tag{11}$$

$$L_{2f}^1 \geq 0 \tag{12}$$

The first three equations are the first order conditions, taking into account that fragment 2 can now be obtained from abroad where the wage rate is w^E, while all other employment takes place at the domestic wage rate w. The fourth line determines how much foreign employment will take place to generate the profit-maximizing amount of fragment 2 in industry 1. We denote this by L_{2f}^1, and it is determined as a residual between what is left from domestic labor endowment and profit maximizing employment in industry 2 and fragment 1 of industry 1. Line 5 states that the domestic wage cannot be lower than w^E. This is ruled out by the fact that firms would then face an incentive to shift, marginally, from foreign to domestic procurement of fragment 2.[9] The final line simply

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[9] In Kohler (2001), I demonstrate that the case $w > w^E$ is ruled out if capital is not fragment-specific in industry 2.

states that foreign employment in fragment-2-production cannot be negative, ruling rules out $\bar{L} - L^2 - L_1^1 > 0$, in which case there would be excess demand for domestic labor. In this equilibrium, the capital stock $\bar{K}_2^1$ is divided between domestic and foreign investment in line with the ratio $L_2^1 / L_{2f}^1 - 1$.

A formal comparative static analysis of this equilibrium is complicated by the inequality conditions. But the result is easily depicted by figure 2 where equilibrium values are denoted by a tilde. The figure assumes that $\tilde{w} = w^E$; a case where $\tilde{w} > w^E$ is easily imagined. Notice that the horizontal distance $\tilde{B}_1^1 \tilde{B}^2$ measures domestic employment in fragment 2, while $\tilde{B}_1^1 \tilde{B}$ measures total (domestic and foreign) employment $\tilde{L}_2^1$ in fragment-2-production in industry 1. It is now easy to see that outsourcing generates a domestic *redistribution of income* from labor to capital. The income loss to domestic labor is equal to $(w^* - \tilde{w}) \times \bar{L}$, all of which ends up as additional income to domestic capital. In addition, domestic capital owners gain on infra-marginal units of re-allocated domestic labor, and on foreign labor. This gain is measured by the shaded triangles in figure 2 which represents a *net welfare gain* to the domestic economy. To return to the above question, the labor initially set free through outsourcing, once reallocated towards alternative domestic use, generates value added equal to $B_1^1 \tilde{B}_1^1 \tilde{L}_1^1 L_1^{1*}$ in fragment 1 of industry 1, plus $BL^{1*}\tilde{L}^2$ in industry 2. It is worth pointing out that outsourcing generates additional employment in fragment 1 of industry 1 value-added. Moreover, domestic and foreign labor taken together generate value added equal to $B\tilde{B}_2^1 \tilde{L}^1 L^{1*}$ in fragment 2 of industry 1. Netting out the labor income lost on previous domestic production of fragment 2 which is equal to $B_1^1 BL^{1*} L_1^{1*}$, we arrive at the above mentioned triangular net welfare gain.

The general conclusion to be drawn from this analysis is that under the conditions stated the welfare effect from outsourcing to a low-wage country is equivalent to the well-known immigration surplus. Borjas (1999) shows for a two-factor world (skilled vs. unskilled labor) that if the skill-mix of immigration is different from that of domestic labor, and if technology is convex and wages adjust in line with the marginal product of labor, then the labor inflow is employed along a downward-sloping marginal product curve, and domestic factor owners enjoy a benefit from infra-marginal units of foreign labor employed. The above welfare effect from outsourcing is completely equivalent, although there is no labor inflow. Generally, a surplus from factor inflows arises if this inflow is employed subject to diminishing marginal productivity in the domestic economy. For Heckscher-Ohlin models with mobile factors employment of the factor inflow may well employed with

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unchanged marginal productivities if there is sufficient room for Rybczynski-type factor reallocation among sectors with differing factor intensities, in which case there would be no surplus for domestic factor owners. In a single-output model, as in Borjas (1999), the diminishing marginal of factor inflow arises if its composition is different from the pre-existing endowment.[10] In the present case it arises because there are specific factors. The movement along a downward-sloping marginal productivity curve corresponding to the immigration-surplus-case is the movement from B to $\tilde{B}$ and from B to $\tilde{B}^2$, respectively.

The analogy to the immigration surplus is, however, not perfect. While the immigration surplus approaches zero if the domestic labor demand schedule becomes flat, as in the case of Rybczynski-type domestic reallocation, the outsourcing surplus arising here is the larger, the larger the elasticities of labor demand in the alternative domestic employment of labor. This is readily seen from figure 2, where the shaded triangles increase in size if the slopes of V_1^1 and V^2 fall in absolute value. The difference is easily explained, however. The immigration surplus as usually portrayed assumes an exogenously given labor inflow, with wages adjusting endogenously. Here, we assume an exogenous wage differential to start with, $w^* - w^E$, and the quantity adjustments (extent of outsourcing as well as domestic labor re-allocation) follow endogenously.

It is quite easy to recognize without any further analysis that the analogy between the "outsourcing-surplus" and the immigration surplus extends well beyond the dimensional confines of this model. As long as there are sector specific factors and labor is mobile across industries and fragments, international fragmentation will be to the disadvantage of domestic labor, but will entail a welfare gain for the economy as a whole.

4   Indivisibility and "discontinuous outsourcing"

In the case depicted by figure 2 firms entertain production of fragment 2 in two different locations, domestically and abroad. This contrasts with recent experience of outsourcing whereby home regions all of a sudden lose whole components of the value-added-process. Indeed, this element of discontinuity may partly be responsible for the great deal of

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[10]Compare this to the general result on distributional effects from fragmentation derived in Kohler (2002), where the factor intensity pattern of outsourcing *relative to the domestic endowment* similarly plays a key role.

apprehension that we sometimes observe about international fragmentation.

Discontinuous behavior usually results from some element of indivisibility, or non-convexity, in technology. I shall now look at outsourcing under the assumption that the capital stock used for fragment 2 in industry 1 is not only specific to that fragment, but also an indivisible input. In other words, the marginal productivity of labor in F_2^1 falls to zero if the stock of capital falls below some critical level, and the marginal productivity of capital is zero for any extension beyond that critical level. This is a convenient way to explore "discontinuous outsourcing" within the present model setup.[11] With such a technology, it is clear that domestic firms have an incentive to avoid an unnecessary duplication of fixed investment, as would be the case with partial outsourcing in figure 2 above. We would expect that they decide to locate production of fragment 2 either at home or abroad, depending on the foreign wage rate w^E and the wage that would prevail at home under alternative decisions, but never choose to simultaneously produce a given fragment in two separate locations.

However, introducing such an element of non-convexity almost by necessity implies some form of deviation from perfect competition. On a fundamental level, if the kind of indivisibility mentioned above is an important general characteristic of industry-1-technology, then good 1 will most likely not be supplied competitively on the world market, and price-taking behavior of domestic firms in this industry becomes a questionable assumption. However, in many cases the indivisibility may not be significant enough to turn the world industry as a whole into an oligopoly, or even a monopoly on the output side. More specifically, monopoly profits and subsequent entry may lead to a sufficiently large number of firms world-wide for each of them to perceive a world market environment with a given price for its final output. Moreover, it is perfectly possible that, non-convexity of their technology notwithstanding, domestic industry-1-firms have no market power when hiring domestic labor where they meet competition from other

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[11] In Kohler (2001), I look at a case where the cost that firms incur when they engage in international fragmentation of a value-added process incorporate a fixed-cost element. However, this does not, as such, constitute an incentive to close down domestic production of individual fragments altogether. Indeed, a result in that paper is that firms will typically retain some domestic production of a fragment that they produce offshore, provided that such offshore production can take place via foreign direct investment, as assumed here. It does, however, entail a potential for a welfare from outsourcing; see Kohler (2001).

domestic industries relying on the same type of labor. I such cases, we may still use the labor market equilibrium depicted by figure 1 as our reference case when considering international fragmentation under the assumption that fragment-2-production relies on an indivisible capital stock which may either be located at home or abroad.

Let n be the number of domestic firms in industry 1, and assume that all firms are symmetric, each of them endowed with the above mentioned minimum stock of fragment-2-capital. We treat point B in figure 1 is our reference equilibrium where each domestic firm chooses a profit maximizing level of domestic employment for fragments 1 and 2, perceiving not only a constant output price, but also a constant domestic wage rate. As above, we now assume that, due to some technological advance in transport and communications or to lower formal barriers, these firms face a foreign wage rate $w^E < w^*$ which constitutes an incentive to move production of fragment 2 abroad, investing the required minimum capital stock abroad rather than domestically.

As a first step, figure 2 can now be interpreted as the outcome in a case where n is "very large", very large meaning that $\tilde{L}^1_{2f}/n$ is smaller or equal to the distance $\tilde{B}^1_1\tilde{B}^2$. In this case, there is room for at least one profit-maximizing firm keeping its fragment-2-production in the domestic economy. There is, thus, an equilibrium which separates firms that remain at home with fragment 2 from firms producing fragment 2 "offshore". In other words, the indivisibility on the firm level is annihilated in the aggregate by the large number of firms, and the welfare gain obtains irrespective of this indivisibility.[12] Whether or not n is sufficiently large for this to happen depends on the fundamental parameters of the economy. This could be brought to the fore by a more extensive model, dealing more explicitly with the non-convexity in sector-2-technology as well as demand and the emerging market structure, ultimately endogenizing n. It is clear, however, even without further modeling that, other things equal, such a case is more likely a) if the wage gap $w^* - w^E$ is large, b) if labor demand elasticities of the domestic activities F^1_1 and Y^2 are low, and c) if the minimum capital stock required is low.

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[12] There is, of course, an "integer problem" here which implies that the "fragmentation equilibrium" may be characterized by a domestic wage rate which is just below w^E.

4.1 Potential welfare loss: the single firm case

However, relying on n being "very large" is neither satisfactory, nor is it a particularly interesting case. Let us therefore assume the opposite case where $n = 1$. There is nothing wrong, in principle, with assuming a single domestic firm in industry 1 which behaves competitively on both, the world market for its output and the domestic labor market where it competes with firms from other industries. However, the option of outsourcing with $w^E < w^*$ fundamentally alters its position vis à vis the domestic labor market.

Suppose employment in fragment 1 is at $\tilde{B}_1^1$ while, due to the underlying indivisibility, all of fragment 2 is produced abroad, with a profit maximizing foreign labor input equal to the distance $\tilde{B}_1^1 \tilde{B}$. Since industry 2 is at point $\tilde{B}^2$, there is *excess supply* on the domestic labor market equal to $\tilde{B}_1^1 \tilde{B}^2$ which exerts a downward pressure on the domestic wage rate. It is important to note that, as the wage rate falls further, domestic fragment-2-employment will not follow line V_1^1, since this is only valid for integrated production, i.e., under the condition that both types of employment are governed by a common wage rate; see equation 4 above. Due to outsourcing, fragment-2-employment is now governed by a constant wage rate w^E different from w. Notice that a domestic wage rate falling below w^E does not constitute an incentive to withdraw, or abstain, from international fragmentation, since investing the (indivisible) fragment-2-capital stock at home would immediately move the economy back to B where industry-1-profits are clearly lower.

In the case where $V_1^1(w^E, \bar{K}_1^1) + V^2(w^E, \bar{K}^2) < \bar{L}$ the domestic labor market equilibrium is determined as follows. In equations 7 and 8, the foreign wage rate w^E becomes an important determinant of industry 1 labor demand. They can be solved for demand functions $\tilde{V}_1^1(w, w^E, \bar{K}_1^1, \bar{K}_2^1)$ and $\tilde{V}_2^1(w, w^E, \bar{K}_1^1, \bar{K}_2^1)$, where $\bar{K}_2^1$ is assumed to be equal to the above mentioned critical level. $\tilde{V}_1^1$ gives profit-maximizing labor demand in fragment 1 which, by assumption, needs to take place domestically, while $\tilde{V}_2^1$ gives profit-maximizing employment in fragment 2 which in this case is is produced abroad at a wage rate equal to w^E. $\tilde{V}_1^1$ might be called a "cum-outsourcing" labor demand curve for fragment 1.

For any $w < w^E$, if we compare $\tilde{V}_1^1$ with $V_1^1(w, \bar{K}_1^1, \bar{K}_2^1)$, the integrated case where fragment 2 is produced by drawing on domestic labor with a wage equal to w (derived from solving equations 4 above), we have $\tilde{V}_1^1 < V_1^1$. This is because our technology assumptions imply $Y_{12}^1 > 0$, and fragment 2 employment in this case does not expand in line with V_2^1, but only to the extent that an increase in fragment 1 production increases the marginal productivity of employment in fragment 2 which faces a constant foreign wage rate w^E.

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In other words, as domestic employment in fragment 1 moves along the schedule $\tilde{V}_1^1$, L_2^1 will increase with an unchanged foreign wage rate w^E, since any increase in L_1^1 increases $\tilde{V}_2^1$. In figure 3, as fragment-1-employment moves from $\tilde{B}_1^1$ to $\tilde{E}_1^1$, fragment-2-employment abroad moves from point $\tilde{B}$ to point $\tilde{E}^1$. Total equilibrium employment in industry 1 is equal to $\tilde{L}^1$, of which $\tilde{L}_1^1$ is domestic and $\tilde{L}_{2f}^1 = \tilde{L}^1 - \tilde{L}_1^1$ is foreign. It is important to realize that, as L_{2f}^1 increases along the schedule $\tilde{V}_2^1$ (from $\tilde{B}$ to $\tilde{E}^1$), each unit of foreign labor receives a wage equal to its marginal value-added. Hence it does not involve any movement along a downward-sloping marginal product schedule which would give rise to a surplus.

Figure 3 reveals that this scenario may involve an overall welfare loss for the home economy. In addition to the positive welfare triangles familiar from figure 2, there is triangular loss. This is caused by the fact that domestic labor reallocated from former fragment-2-employment to fragment 1 and industry 2, respectively, generates less value-added than it did before. Prior to its reallocation, this labor has received income equal to the rectangle $B_1^1 B L^{1*} L_1^{1*}$. Now, its income has fallen to $C'D'L^{1*}L_1^{1*}$ which is equal to $(L^{1*} - L_1^{1*}) \times \tilde{w}$. The difference is not completely offset by the immediate cost-savings effect $B_1^1 B D C$, plus the additional capital income generated on infra-marginal labor now employed in industry 2 and fragment 1, respectively, which is equal to $B\tilde{E}_1^1 D'$ plus $B_1^1 \tilde{B}_1^1 \tilde{E}_1^1 C'$. Only if the triangle $\tilde{B}_1^1 \tilde{B}^2 \tilde{E}_1^1$ is smaller in size than the double-triangular gain that we have identified in the simpler case above, will international fragmentation give rise to a positive "outsourcing-surplus".

A negative "fragmentation-surplus" arises only if $\tilde{w} < w^E$. It is quite illustrative to look at a necessary condition for this to arise. Suppose η_1^1 is the elasticity of V_1^1 with respect to w, and η^2 is the elasticity of V^2. Moreover, define $\omega = w^E/w^* - 1$ as the percentage *wage gap* between the domestic wage rate and the effective foreign wage rate that forms the basis for international fragmentation. Then, the condition under which international fragmentation leads to a wage rate $\tilde{w} < w^E$ may be approximated by

$$L_1^{1*}\eta_1^1\omega + L^{2*}\eta^2\omega < L_2^{1*}, \tag{13}$$

where a star indicates employment levels in the initial equilibrium.[13] The left-hand side

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[13]This is an approximation, because we apply a discrete wage different to the labor demand elasticities which need not be constant.

gives the additional employment arising in fragment 1 of industry 1 and industry 2 if the domestic wage rate falls down to w^E. If this is smaller than the employment lost due to outsourcing, then domestic labor market equilibrium requires $\tilde{w} < w^E$.

Notice that by construction of our argument $\omega < 0$. Assuming normal labor demand schedules as in our figures, η_1^1 and η^2 are also negative. Condition 13 may be rewritten as

$$|\omega|^{-1} > \frac{L_1^{1*}}{L_2^{1*}}\eta_1^1 + \frac{L^{2*}}{L_2^{1*}}\eta^2, \tag{14}$$

stating that the wage gap must be small in absolute value, relative to the weighted sum of labor demand elasticities in the remaining domestic activities, whereby each of these elasticities receives a "weight" equal to the size of its employment relative to the employment lost to outsourcing. It is obvious that condition 14 generalizes to cases where there are more then two industries, and also to cases where there is more than 1 fragment that moves "offshore". Another way to look at this condition which may shed more light on the issue is to introduce proper weights $\lambda_1^1 = L_1^{1*}/(L_1^{1*} + L^{2*})$ and $\lambda^2 = 1 - \lambda_1^1$, so that the condition 14 appears as

$$\frac{(L_1^{1*} + L^{2*})(w^* - w^E)}{w^* L_2^{1*}} < \frac{1}{\lambda_1^1 |\eta_1^1| + \lambda^2 |\eta^2|}. \tag{15}$$

A general interpretation of condition 15 runs as follows. International fragmentation will always involve a separation of activities which are moved abroad from those which remain domestic. The left-hand side of condition 15 measures the cost-effect of the wage gap if applied to the initial levels of those activities which for some reason are ruled out from outsourcing ("non-outsourcing activities"), relative to the initial wage cost of the fragment which will eventually be lost to outsourcing. The right-hand side is simply the inverse of the weighted sum, in absolute terms, of labor demand elasticities of the "non-outsourcing activities".

The general lesson to be learnt from this analysis is quite important. Policy discussions often concentrate on the wage difference $w^* - w^E$ as a measure of the "threat" that globalization may pose to "high-wage-countries". This view is in marked contrast to the general conclusion to be drawn from this analysis. A welfare loss for the domestic economy (negative "outsourcing-surplus") is the more likely, the smaller this gap. Nor is the redistribution effect determined by this gap, as is most easily recognized by simply altering the level of w^E in figure 3. The domestic wage effect of outsourcing, $\tilde{w} - w^*$, is dependent on the characteristics of those production activities that remain in the domestic

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economy, in this case industry 2 and fragment 1 of industry 1, and not at all by the size of the wage gap. It is, however, also determined by the significance that the fragment lost to the foreign economy has for the domestic labor market.[14]

4.2 Multiple firms: the non-cooperative equilibrium

Figure 2 may be interpreted as a case where n is "very large", so that the indivisibility on the firm level is annihilated in the aggregate, while figure 3 depicts the case with $n = 1$. What about the the intermediate case with $n > 1$ but "small"? "Small" in this case may have two distinct meanings. The first is that n is sufficiently small, so that the profit-maximizing level of fragment-2-employment of a single representative firm facing a wage rate w^E is larger than the distance $\tilde{B}_1^1 \tilde{B}^2$ in the above figures. If n is "small" in this sense, then figure 2 where there is some domestic production of fragment 2 cannot represent an equilibrium situation. The reason is that any firm maintaining domestic production of fragment 2 would increase the domestic wage rate above w^E, and it could, therefore, increase its profit by means of outsourcing. Hence, in this case all firms will produce fragment 2 "offshore", and the resulting equilibrium is fully described by figure 3. Without entering any formal modeling towards endogenizing n, we have identified the key magnitudes that will determine whether n is "very large"; see above. The same reasoning can now be applied for the question of whether n is "too small" to support any domestic production of fragment 2, given the wage gap $w^* - w^E$, so that we end up in a situation like figure 3, although there is now more than just a single domestic industry-1-firm.

The remaining question then is whether any case where n is large enough to support positive domestic production of fragment 2 at all, will automatically lead us back to figure 2, i.e., the case where indivisibility simply doesn't matter (apart from the "integer problem"). The answer is no, and the basic reason is as follows. Notice first that the crucial difference between figures 2 and 3 is that in figure 3 the domestic wage rate $\tilde{w}$ is below w^E. The crucial question is how this difference can be maintained in equilibrium. In the single firm case this is guaranteed by the firm realizing that any "move back" would drive the wage rate all the way up to w^*. The point now is that, unless n is "very large", each firm choosing an outsourcing strategy and considering to "move back" will similarly

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[14]A similar thrust is also emerging from the general analysis of distributional effects in Kohler (2002).

conjecture a domestic wage increase, and I will presently show that this may support a gap between w^E and the domestic wage rate in equilibrium.

It is perhaps worth acquiring some basic intuition for this case, before entering some formal modeling. Let us assume, for simplicity, that all domestic firms are completely symmetric. Consider a case where some firms produce fragment 2 abroad, while others maintain domestic production of this fragment, and suppose the domestic wage rate lies somewhere in between w^E and $\tilde{w}$ in figure 3. This implies that the condition 15 is met. Obviously, given the higher wage rate w^E, no firm presently choosing an integrated domestic production (no-outsourcing strategy) will have an incentive to change its strategy. The question is whether there is an incentive for a representative firm choosing an outsourcing strategy to withdraw from outsourcing, i.e., to "move back". If it doesn't, and then the situation constitutes a Nash equilibrium, establishing a case between figure 2 (with a domestic wage equal to w^E) and figure 3 (with a domestic wage rate $\tilde{w}$).

The pay-off that a representative firm expects from moving fragment 2 back to the home economy is determined by two effects. First, by the cost-savings achieved from producing fragment 2 at the lower domestic wage rate. The second effect derives from the fact that such a move will drive up the domestic wage, thereby also increasing its cost on fragment 1. If n is "very large", then this second effect is negligible, but if the number of firms is sufficiently small, each of them may conjecture a domestic wage increase when deciding whether it should "move back". A non-cooperative Nash equilibrium requires that a representative firm, by adding these two effects and assuming that all other firms maintain their strategies (outsourcing vs. domestic production of fragment 2), will not find an incentive to change its strategy.

Suppose $\nu \leq 1$ is the share of domestic firms that are engaged in outsourcing and the domestic wage rate is equal to $\bar{w} \geq \tilde{w}$, where $\tilde{w}$ is defined as the wage rate that would prevail if there were no domestic production of fragment 2 at all (figure 3). By construction of my argument, we also have $\bar{w} < w^E$. It is worth remembering here that w^E is the wage rate per efficiency unit of foreign labor, including costs of international fragmentation. Hence the situation could well be such that the wage rate for a natural unit of foreign labor is below $\bar{w}$. The amount of foreign labor that a representative firm employs in foreign fragment-2-production is denoted by $\bar{l}_{2f}^1$. Other things equal, there will be a negative relationship between $\bar{l}_{2f}^1$ and n, the total number of domestic firms in industry 1.

To see if this is a Nash equilibrium, we must calculate the domestic wage rate that a typical outsourcing-firm perceives would be the outcome if it were to move its fragment-2-production back to the domestic economy. We use $\hat{w}^c$ to denote the percentage wage increase from $\bar{w}$ that such a firm conjectures as a result of "moving back". This will depend on how the firm perceives the domestic labor market. Suppose that it conjectures an elasticity η^c of domestic labor demand with respect to the domestic wage rate, including its own labor demand for production of fragment 1.[15] Moreover, assume that $\tilde{\eta}_2^1$ is the elasticity of $\tilde{V}_2^1$ with respect to w^E at the point where $w = \bar{w}$. Notice that $\eta^c < 0$ and $\tilde{\eta}_2^1 < 0$. The firm will thus conjecture a domestic wage effect $\hat{w}^c$ which may approximately be described by the following expression:[16]

$$- \left(\eta^c L + \tilde{\eta}_2^1 \bar{l}_{2f}^1 \right) \hat{w}^c = \bar{l}_{2f}^1 \left[1 - \tilde{\eta}_2^1 \left(w^E - \bar{w} \right) \right]. \tag{16}$$

The right-hand side of this equation gives the impact demand effect on the domestic labor market that arises if the firm switches from an outsourcing strategy to integrated domestic production, including the fact that employment in fragment 2 will be higher at the domestic wage rate which is below w^E. The left-hand side gives the labor demand effect arising from the conjectured wage-increase, again including the firm's own reaction. Equation 16 thus implicitly determines the conjectured wage increase by requiring that the two conjectured demand effects just offset each other. Solving for $\hat{w}^c$ gives

$$\hat{w}^c = -\frac{1}{\eta^c / \gamma_2^1 + \tilde{\eta}_2^1} + \frac{\tilde{\eta}_2^1}{\eta^c / \gamma_2^1 + \tilde{\eta}_2^1} \left(w^E - \bar{w} \right). \tag{17}$$

In this equation, $\gamma_2^1 = l_2^{1f} \big/ L$ captures the quantitative significance of a typical outsourcing firm's foreign labor demand, relative to the size of the domestic labor market L.

With given γ_2^1, and assuming constant perceived labor demand elasticities, there is a positive linear relationship between the wage-gap $w^E - \bar{w}$ and the conjectured wage

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[15] In our model, domestic labor is emloyed by industry 2, as well as industry-1-firms, all of which continue producing fragment 1 domestically. In addition, there is domestic employment in fragment-2-production if $\nu < 1$. We do not enter any explicit modeling of how the true elasticities of labor demand in these types of employment are related to the conjectured elasticity η^c, but it is reasonable that there is some link. In any case, it is the conjectured elasticity that matters at this stage.

[16] Again, this is only an approximation, as we are applying a discrete wage difference to labor demand elasticities which need not be constant.

increase from "moving back". However, when considering alternative values of $\bar{w}$ the term γ_2^1 cannot be held constant, because there is a cross-fragment relationship in production. We have started our argument with some arbitrary share $\nu \leq 1$ of domestic firms that choose an outsourcing strategy, and the question is whether or not this constitutes a symmetric Nash equilibrium. But $\bar{w}$ is not independent on ν, nor is $\bar{l}_{2f}^1$, even for given n. Other things being equal, a higher $\bar{w}$ will be associated with a lower ν, and lower employment $\bar{l}_{2f}^1$ per firm. A fall in ν implies additional domestic production of fragment 2, with higher domestic labor demand and a higher associated domestic wage rate $\bar{w}$. Fragment-1-employment will, thus, be lower for all firms, including those choosing an outsourcing strategy on fragment 2. This, in turn, depresses the marginal productivity of labor in their foreign production of fragment-2. This effect is driven by the elasticity of labor demand in fragment 1, $\tilde{\eta}_1^1$, and by the cross-fragment effect of an increase in F_1^1 on $\tilde{V}_2^1$. As a result, each outsourcing firm will choose a lower fragment-2-employment at the given foreign wage rate w^E. Without going into details, we may summarize this by means of $\gamma_2^1(\bar{w})$, with a negative derivative.

Turning to figure 4 which depicts this conjectured wage effect, the consequence of this cross-fragment relationship is that γ_2^1 rises, as $w^E - \bar{w}$ increases. The intuition is that, since $\bar{l}_{2f}^1$ increases with a higher wage gap $w^E - \bar{w}$, the domestic labor demand effect from "moving back" will be higher. Therefore, each firm will expect a higher domestic wage increase in case it moves back. In addition, it implies a higher leverage for increasing cost due to this wage increase. I now proceed with a reduced form relationship

$$\hat{w}^c = \Gamma(w^E - \bar{w}), \tag{18}$$

which derives from 17, and the dependence of γ_2^1 on $\bar{w}$ that arises from the cross-fragment relationship, i.e., $\gamma_2^1(\bar{w})$. This is positively sloped, and if the cross-fragment relationship is not too strong it has a slope less than 1. In figure 4, equation 18 is depicted by the line labeled "conjectured wage effect".[17] Other things equal, this shifts upward and becomes steeper with a fall in n; see 17 above.

Whether or not a switch from outsourcing to domestic production pays off in the eyes of the firm depends on the cost-effect on both fragments. Denoting the cost-shares of the two fragments by θ_i^1 and the share of wage cost in fragment i by θ_{iL}^1, the condition for

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[17]Linearity is, of course, only a matter of simpler drawing.

such a switch to be cost-saving is

$$\theta_1^1 \theta_{1L}^1 \hat{w}^c - \theta_2^1 \theta_{2L}^1 \left[w^E - (\bar{w} + \hat{w}^c) \right] < 0. \tag{19}$$

This condition can be rewritten as

$$\hat{w}^c < \frac{\theta_2^1 \theta_{2L}^1}{\left(1 - \theta_2^1\right) \theta_{1L}^1 + \theta_2^1 \theta_{2L}^1} \left(w^E - \bar{w} \right). \tag{20}$$

In figure 4, the shaded area underneath the line labeled "cost-savings condition" corresponds to wage increases satisfying condition 20. The flatter line depicts the conjectured wage effect given in equation 18 above. Notice that the cost-savings line has a slope less than 1.[18]

The case where the conjectured wage line nowhere intersects with the cost-savings condition must be interpreted as being equivalent to the single-firm case, where the equilibrium domestic wage rate is equal to $\tilde{w}$ in figure 3 above. I have called this the case where n is "too small for figure 2" above. In figure 4, the equilibrium in this case has $\nu^* = 1$. Notice that figure 4 assumes condition 15 to be met. The position of the vertical $\nu = 1$- line at $w^E - \tilde{w}$ is determined just as $\tilde{w}$ is in figure 3, although we now have more than one domestic firm in industry 1.

If there is an intersection point, this constitutes a Nash equilibrium, as with the domestic wage rate $\bar{w}^*$ in figure 4: the wage gap $w^E - \bar{w}^*$ is supported by the fact that a representative outsourcing firm will conjecture a domestic wage effect from "moving back" which just offsets the apparent cost advantage from the wage gap. One may also construct adjustment processes, whereby, as long as the domestic wage rate $\bar{w}$ is such that the economy is in the shaded area, a typical outsourcing firm anticipates that a switch from a strategy of outsourcing to integrated domestic production will pay off in terms of higher profits. As a result, ν, the share of firms engaged in outsourcing will shrink, and the domestic wage rate increases until it reaches an equilibrium value of $\bar{w}^*$, as implied by the intersection point between the two lines.

4.3   Issues of interpretation

There are a few issues of interpretation that arise in the case where outsourcing happens under conditions of indivisibility, and which are worth commenting on. First, in the Nash

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[18]Again, linearity is only a matter of simpler drawing.

equilibrium just described, firms engaged in outsourcing have lower profits (or capital rental) than firms choosing an integrated domestic production mode. While the coexistence of both strategies in a single industry is not unusual, if anything one would perhaps expect an opposite profit asymmetry. One may also wonder about the stability of such an equilibrium. The asymmetry does not, however, mean that firms harm themselves by choosing fragmented production. It only means that after those choosing an outsourcing strategy have left, those who don't will enjoy the benefit of a lower domestic wage. At the same time, by definition of the Nash equilibrium, this wage differential does not constitute an incentive to "move back", because the conjectured wage increase would undo the benefit of a lower domestic wage. Notice again that the lower domestic wage is in terms of efficiency units, including any additional cost due to international fragmentation as such; see above. Of course, even with a relatively small number of domestic firms, the conjectured wage effect may not be large enough for any significant difference between w^E and $\bar{w}^*$ to be left in equilibrium. This is the case where the conjectured wage line starts close to the origin and is very flat, whence $\bar{w}^*$ approaches w^E. This effectively moves us back to figure 2. Notice, however, that this does not correspond to ν approaching zero, since this would imply a domestic wage rate equal to w^* which, given $w^E < w^*$, cannot be an equilibrium. The precise value of ν^* is not of so much interest, however. More interesting is the difference between w^E and $\bar{w}^*$, since this is crucial for the welfare effect and the possibility of a welfare loss; see figure 3.

And it is this welfare aspect where a second issue of interpretation arises. Figure 3 assumes as the point of departure a case where there is perfect competition on the domestic labor market. A crucial variable for the equilibrium wage gap $w^E - \bar{w}^*$ arising in figure 4 is γ_2^1 which, in turn, is defined as $\bar{l}_{2f}^1 / L$: the labor demand of a representative firm in foreign fragment-2-production, relative to the total size of the domestic labor market. One may argue that this is non-negligible only if a representative firm has a non-negligible influence in the domestic labor market to start with, in which case the assumption of competitive firm behavior on the domestic labor market is questionable. Two different questions should to be separated here. One is the equilibrium value of $\bar{w}^*$ as such, and particularly whether a low value of γ_2^1 will almost by necessity cause $\bar{w}^*$ to be close to w^E, ruling out a negative "outsourcing surplus". The other is wether the equilibrium portrayed in figure 1 is a valid reference case for determining the welfare effect of international fragmentation if γ_2^1 is assumed to be significantly different from zero. I

shall return to this second question in the next section. As regards the first, it is clear that as γ_2^1 approaches zero, the conjectured wage line in figure 4 gets shifted towards the origin and its slope approaches 1; see 17. Since the cost-savings line always has a slope less than 1 (see equation 20), this would indeed imply $\bar{w}^* = w^E$. However, it should be noticed that for a low cost-share of labor in fragment 1 and a very low cost-share of fragment 1 in industry 1, the slope of the cost-savings line similarly approaches a value of one. Hence, even for a relatively steep conjectured wage line there may be an interior intersection point.

5 Market power on the domestic labor market

I now turn to the second question of whether assuming a non-negligible value of γ_2^1 also implies a reference equilibrium different from figure 1, i.e., an equilibrium where firms in industry 1 perceive market power on the domestic labor market. In many cases, particularly in Europe, relevant labor markets are pretty small and regional in nature, meaning that they cover a small region with a high degree of internal labor mobility between a small number of industries, but with very low mobility across such regions. Outsourcing should then be an interesting option for firms to arbitrage on wage differences, and it should become particularly relevant at the eastern periphery of western Europe vis a vis neighboring regions of central and east European transition countries where wages are low and barriers are falling.

Available space does not permit a full-fledged analysis of the case where firms in industry 1 have monopsony power on the local labor market to start with. But, based on the above analysis which assumes a reference equilibrium with competitive behavior of industry-1-firms, some interesting implications are easily pointed out. To make matters simple, we may assume that there is a single domestic firm in industry 1. It will equate the marginal product of labor employed in the two fragments F_1^1 and F_2^1 to the marginal cost of labor which is not equal to the wage rate, but depends on the marginal product curve of industry 2. With given labor endowment, that curve acts as a labor supply curve to the firm in industry 1.

Thus, in the reference case where all production is integrated domestically, the employment decision of this firm in its two fragments is subject to movements along the

$V^2(w, \bar{K}^2)$ curve of industry 2:

$$V^{2\prime}(w)\,\mathrm{d}w = -\mathrm{d}L_1^1 - \mathrm{d}L_2^1. \tag{21}$$

The reference equilibrium will feature a markup between marginal productivities of labor in both fragments and the domestic wage rate w^*. This also entails a welfare loss, relative to the case depicted in figure 1.

Now suppose, as before, that this firm faces the option to procure fragment 2 via outsourcing at a given foreign wage rate w^E. A first interesting point is that outsourcing may arise even if $w^E > w^*$. The reason is that the relevant comparison is between w^E and the domestic marginal cost of labor which is $w^* (1 + \mu)$, where μ is the afore mentioned markup.

One might wonder if this case even entails a potential for a domestic wage increase upon outsourcing. To see if this is indeed the case, one needs to consider two things. First, the drain on domestic labor demand from outsourcing clearly exerts a downward pressure on the wage rate. But there are two potentially offsetting effects. One is that, other things equal, an increase in fragment-2-production raises the marginal productivity of labor in domestic fragment 1. And the other is that outsourcing also affects the marginal cost of domestic labor. Before, any additional unit of labor employed in domestic production, through an associated wage increase, has caused additional cost of all labor employment in *both* fragments. Now, with employment on fragment 2 available at a constant foreign wage rate w^E, this infra-marginal cost effect only relates to fragment 1. Hence, other things equal, the marginal cost of employment falls. These two offsetting effects might, indeed, produce what seems like a rather odd result: Outsourcing is targeted towards a high-wage region, and it causes a domestic wage increase.

The most important difference, however, relates to welfare. Outsourcing now entails a first-order welfare effect, over and above the above welfare triangles. The reason is that there is an initial distortion in domestic labor allocation where too much is employed in sector 2, and too little in sector 1. At the margin, labor has a higher productivity if employed in industry 1 than in industry 2. As outsourcing causes a re-allocation of labor towards industry 2, one might expect that there is a negative first order-effect. However, a little reflection along the lines of figures 2 and 3 reveals that this need not be the case. The distortion initially present in fragment-2-employment is annihilated by outsourcing as such, and this involves infra-marginal gains on employment of foreign

labor which exceed the marginal product of labor in industry 2. Most importantly, a negative first-order effect arises only if the increase in industry-2-employment is at the expense of industry 1. But with outsourcing as the driving element, industry 2 expands simultaneously with employment in fragment 1 of industry 1; see figures 2 and 3 above. Hence, the first-order welfare effect of reallocation which derives from market power of industry 1 on the domestic labor market need not be negative. However, to pin down the effects more precisely we would need further formal analysis which space does not permit at this stage.

6   Conclusions

In concluding, I should like to get back to the question of adjusting to globalization. To governments, the adjustment challenge seldom arises in the context of a grand picture of a truly global change. Very often it arises in a pretty narrow, or even local context whereby a certain region feels threatened by the fact that the protective economic distance to certain foreign regions, however close or far away in geographic terms, progressively loses its significance. This, at least, holds for fragmentation and outsourcing as a specific form, or vehicle, of globalization. The policy challenge from international fragmentation is thus almost always a pretty local one, even if the foreign region is far away, as for instance with the Indian call centers. The question then is whether policy should do something about a certain regional (not even national) labor market where jobs are lost to outsourcing. And the temptation often is to answer in the affirmative.

The purpose of the analysis offered in this paper is to help framing this issue in a more focused way, identifying specific questions that will almost always be important to ask, providing a modeling framework that may be employed to answer these questions, however tentatively, and pointing out relevant criteria to employ towards policy formation. Although the paper has stopped way before suggesting specific policy measures, a number of important insights have emerged.

If outsourcing happens in world of perfect markets, then the case for an active policy response is restricted to distributional policy objectives. There will almost always be redistribution effects which may run counter to the (implicit of explicit) distributional objective pursued in society. This is by no means new or special to outsourcing, nor is the economists' response which, for that reason, I didn't even touch upon above: Do

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something about if it is in conflict with your view of justice, but do not interfere with fragmentation or outsourcing as such. Use first-best lump-sum measures instead.

An important and less evident point to add is that the precise direction of distributional effects of outsourcing is often difficult to identify. Looking at reality alone is potentially misleading if other determinants of factor prices change as well. The above theoretical analysis seems to suggest that labor employed in the value-added chains lost to foreign regions will always lose, to the advantage of other factors. One should, however, warn against too far-reaching generalizations from this impression. Distributional effects are highly sensitive to specific modeling assumptions, and it is not too difficult to find examples, particularly where all factors are mobile, where the effects are contrary to what has transpired as a seemingly robust result from the present analysis.[19] However, from a policy perspective this problem seems like a non-issue, at least if the precise cause of an unwelcome change in factor prices and income distribution does not matter for its desirability. If it is deemed undesirable, it should be corrected, whatever the cause. And this should be done in a distortion-free, first-best manner.

A more formidable challenge relates to the efficiency aspect of fragmentation or outsourcing. Here, the crucial questioned emphasized by the above analysis is whether or not the resources set free through outsourcing will find alternative employment, where they generate value added which is comparable in size to what they have generated before. The general message emerging in this regard, often inadequately acknowledged in policy-oreinted discussions about international outsourcing and fragmentation, is that one should look at what outsourcing implies for the activities that remain in the domestic region, and not so much at the specific characteristics of the value-added fragments lost. We have seen that if there are sector-specific factors in a world with constant returns to scale, these remaining domestic activities will give rise to a welfare gain from outsourcing which is analogous to the "immigration surplus" accruing to the indigenous factors of the recipient region. Unlike the "immigration surplus", however, the "outsourcing-surplus" will be the higher, the higher the elasticities of demand in the remaining activities for the type of labor (or more generally factors) that is lost to fragmentation.

As always, the policy challenge gets more involved if markets for some reason or other

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[19]See Kohler (2002) where I discuss the literature and look at distributional effects from a general perspective.

are subject to imperfections. An imperfection which is often present in outsourcing relates to indivisibilities (or non-convexities) in production, which may, in turn, be responsible for the fact that single firms hardly ever maintain any domestic production of a certain value-added slice, once they take the option of procuring it via outsourcing. Such indivisibilities may cause situations where the resources set free through outsourcing do not generate sufficient value added in their alternative use, even under otherwise optimal factor market institutions, for fragmentation to be welfare enhancing. Analyzing such cases is complicated by the fact that non-convexities, like fixed capital-inputs for individual fragments of the production process as assumed above, in some sense most likely also involves imperfect competition.

The analysis has revealed a relatively straightforward necessary condition for a welfare loss to arise from outsourcing: the resulting domestic wage rate must be lower, corrected for efficiency differences and costs of international fragmentation, than the wage rate in the region which receives the formerly domestic fragment of value-added. This should be a criterion which is, in principle, amenable to empirical application. But it is only necessary, and not sufficient for a welfare loss. Hence it does not justify active policy.

But even if conditions are such that the "outsourcing-surplus" is negative, it is by no means trivially clear what the optimal policy response should be. This is a question which I have left unattended in the paper, and which warrants separate analysis. Moreover, as I have just mentioned, the analysis establishing the possibility of a negative "surplus" rests on the assumption that market are otherwise functioning perfectly, except for the indivisibility in outsourcing technology. Even if some further analysis should tell us what the optimal policy reaction would be in this case, that same policy almost certainly is no longer optimal, and may indeed be detrimental, under less well-functioning markets. This is a straightforward point from the theory of the second-best, and it would seem particularly relevant for the labor market which are a prime candidate for a less optimistic modeling assumption.

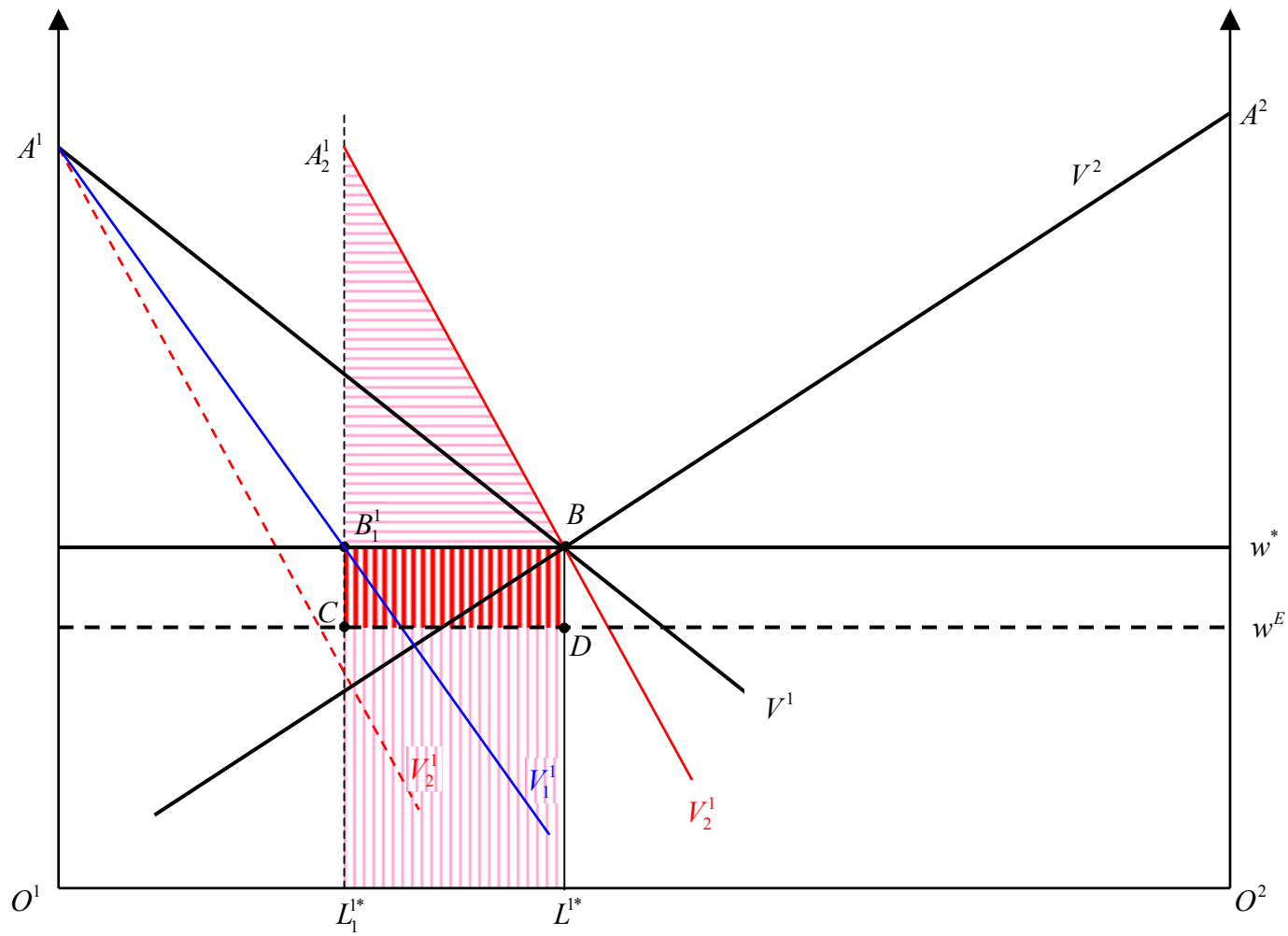**Figure 1:** The cost savings effect of outsourcing

Figure 2: Welfare and distributional effects of international fragmentation
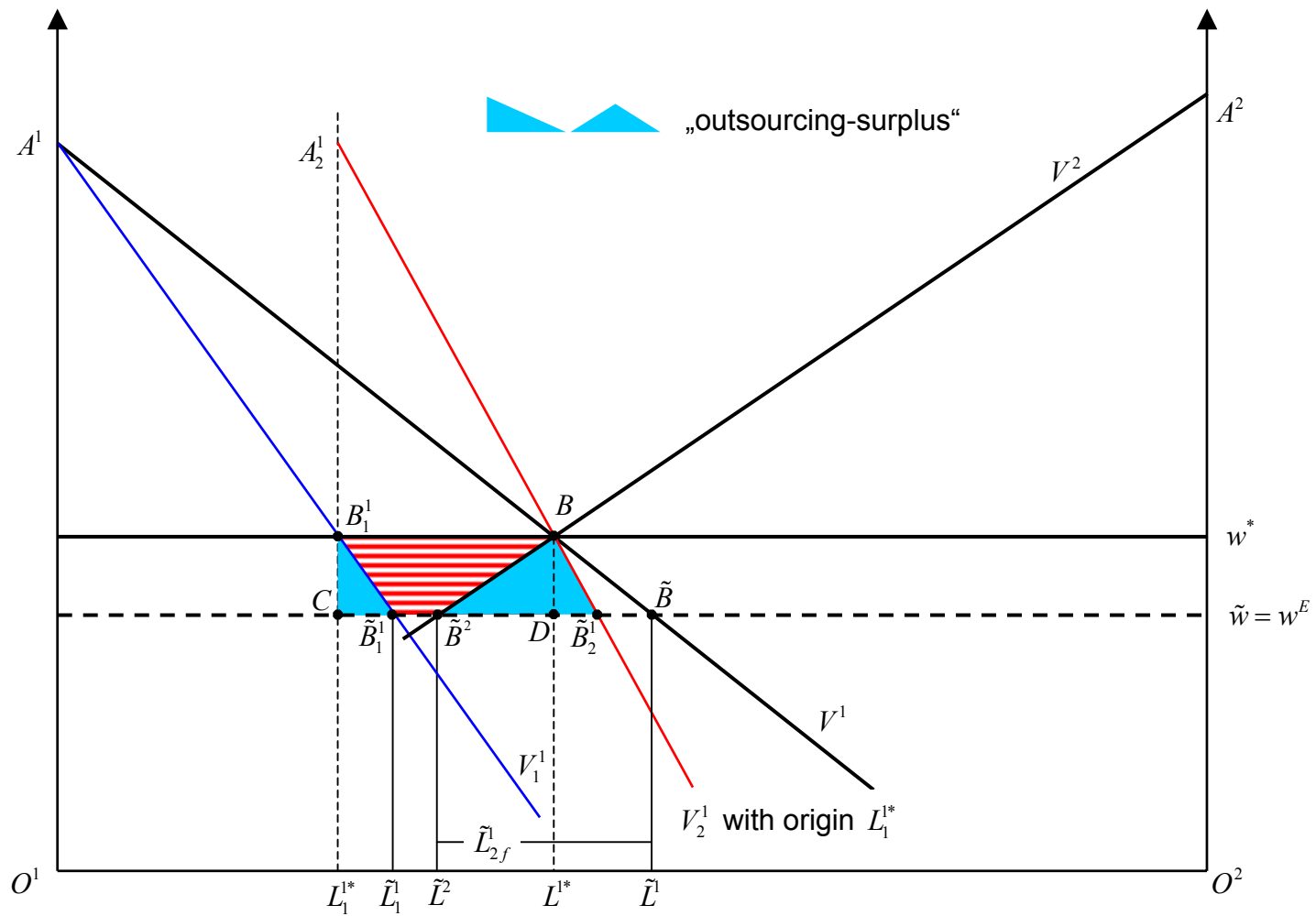*Case I - no indivisibility*

Figure 3: Welfare and distributional effects of international fragmentation
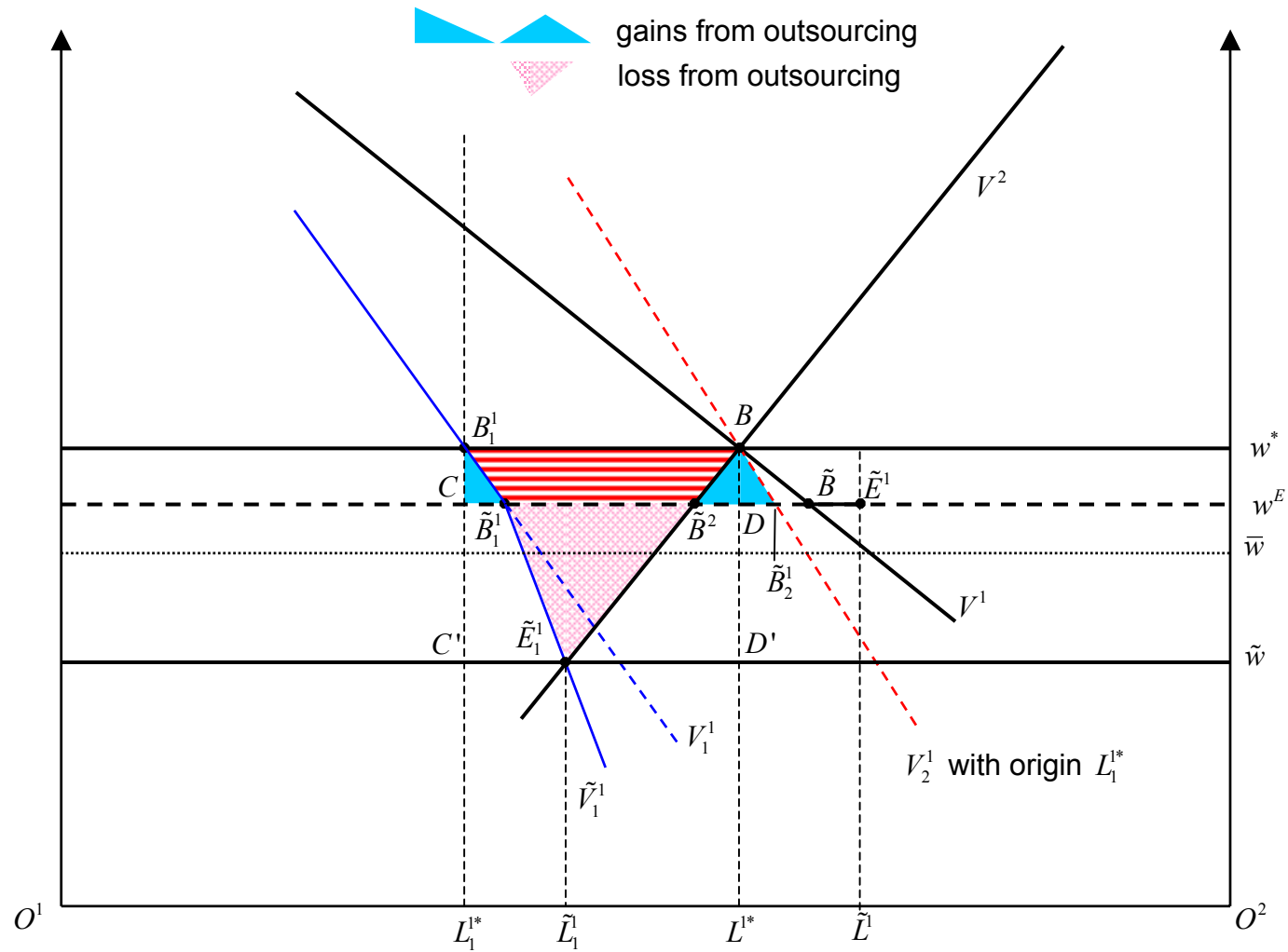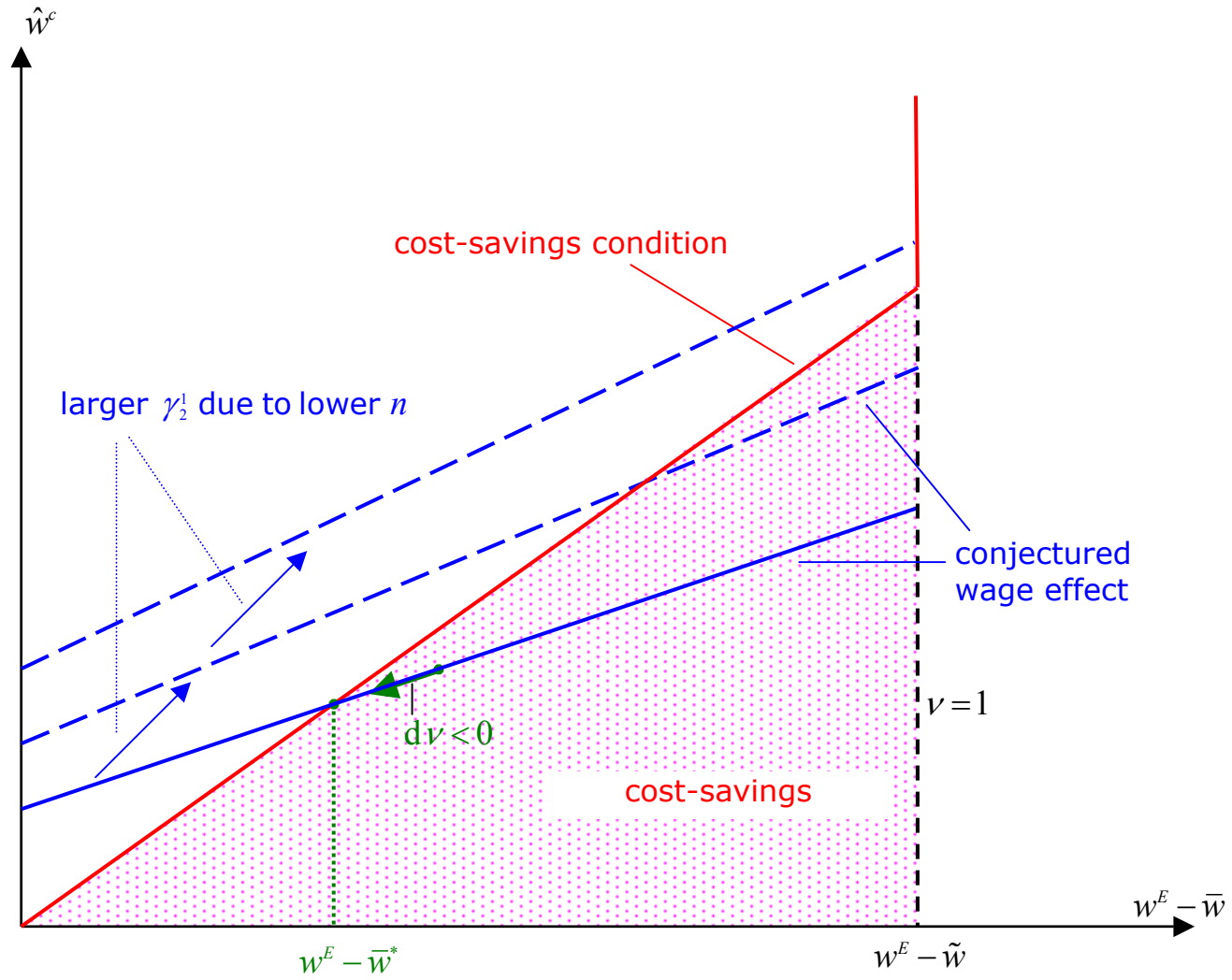*Case II - indivisible capital stock*

Figure 4: Non-cooperative "outsourcing equilibrium"

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