Optimal Domestic Regulation and the Pattern of Trade*

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Abstract: This paper analyzes the impact of asymmetric information within countries on the pattern of international trade. We append to the standard 2×2 Heckscher-Ohlin model of a small economy a continuum of sectors producing intermediate non-tradable goods. Those goods are produced by monopolies having private information on their technologies. With asymmetric information and under optimal regulation, production in these sectors is inefficiently low. The small open country is relatively richer in the factor which is more intensively used by the privately informed sectors. Asymmetric information can reverse the country's pattern of comparative advantages. Due to the existence of information rents in these sectors, the economy receives also not only the standard factor endowments (capital and labor) but also an *"informational endowment"* which boosts demand for tradable goods. Free trade is Pareto is dominated by autarky when, under asymmetric information, there is a reversal of comparative advantages.

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1 Introduction

One of the founding principles of trade theory is that, under well-specified circumstances, most noticeably perfect competition, no externalities and complete information, free trade improves welfare. Of course, economists have long been aware that this result may fail when some of these assumptions are no longer satisfied. Still, it is in the common wisdom that, with enough policy instruments correcting for domestic distortions, a small economy would benefit from opening its borders to international transactions. Free from domestic distortions, trade integration is then likely to generate a welfare superior outcome. This argument relies on the fact that, within such an economy, the allocative gains from trade can be costlessly redistributed. The present paper revisits and challenges that general principle under asymmetric information. Under asymmetric information, one can lo longer separate the efficiency gains from free trade from redistribution issues. with that basic principle in mind, in this paper, we trace out the implications of asymmetric information for the degree of international competitiveness and specialization of a small open country and derive normative implications for trade integration and openness. We ask whether asymmetric information may cause a reversal in the patterns of comparative advantages and whether trade openness remains Pareto-improving.

To fix ideas, we consider a small open economy with two factors (capital and labor) and two final goods traded on international markets and produced by competitive sectors. Following Hecksher and Ohlin, one of the final good sector is supposed to be capital intensive while the other is instead labor intensive. Those sectors use also some non-tradable intermediate goods produced domestically. One may think of telecommunications, electricity, transportations and services alike. Within each of these intermediate sectors, production is made by a monopoly using labor only. Owners of those monopolies have private information on their technologies. To correct the distortions due to monopoly power, regulation is thus called for. However, government intervention is constrained by the lack of knowledge on the relevant information.

Our first contribution is to show how asymmetric information in the regulated sector affects the structure of the country's comparative advantages and its pattern of specialization. It is well-known from standard contract theory[1] that inducing information revelation from privately informed firms requires to leave them some information rents. Since these rents are socially costly, optimal regulation calls for reducing the source of those rents. This is obtained by distorting downwards production in the intermediate sectors. Since these sectors use labor only, more labor becomes available for the labor intensive tradable good. This makes that good relatively cheaper to produce. With asymmetric information, everything happens thus as if the small country was relatively richer in the factor which

[1] See Laffont and Tirole (1993) and Laffont and Martimort (2002, Chapter 2) for instance.

is more intensively used by the privately informed sectors. This may change the pattern of trade with the rest of the world.

In general equilibrium, this change in comparative advantages is not the only impact of asymmetric information. Information rents are indeed redistributed to the representative consumer, who *in fine*, benefits not only from the incomes associated to the usual factor endowments of this economy but also pockets an *"informational endowment".* This affects the demand for tradable goods. Compared to the case without asymmetric information, the existence of this "informational endowment" scales up the demand for both tradable goods. With Cobb-Douglas preferences, this does not change the relative demand for those goods and the pattern of trade is entirely dictated by the comparative advantage in producing the labor intensive good which is a direct consequence of contracting activities in informationally sensitive sectors.

The second contribution of this paper is to investigate the normative implications of free trade under asymmetric information. A priori, there are two sources of distortions in the economy. First, monopolies in intermediate sectors charge a mark-up to exert their market power. Second, asymmetry of information between final and intermediate sectors also affects the allocation of resources. Optimal regulation of the intermediate sectors easily controls for market power distortions under complete information. In such context, free trade would always dominate autarky for a small open economy. Asymmetric information is a more serious issue even if intermediate sectors are optimally regulated. It is indeed the source of a significant wedge between price and marginal cost in intermediate sectors, a mark-up which remains even *after* policy intervention. Given the dead-weight loss associated to those fundamental distortions, free trade may not always dominate autarky.

For Cobb-Douglas utility functions, we fully characterize the conditions under which free trade dominates autarky. Contrary to what happens under complete information, free trade can now be sometimes *Pareto inferior to autarky.* The intuition for this result is quite simple. To minimize information rents arising in the intermediate sectors, optimal regulation reduces output in those sectors. If openness induces a pattern of specialization which reinforces this domestic distortion, this additional distortionary effect may out weight the traditional gains of trade. Free trade is eventually dominated by autarky. This will be the case, under asymmetric information, there is a reversal of the pattern of comparative advantages.

Our paper is related to several branches of the literature. First, starting with the beautiful synthetic work of Bhagwati (1971), there has been quite a large amount of research in the trade literature devoted to building an analytical framework to assess distortions away from free trade and to discuss how these distortions can be corrected.[2] Following the taxonomy due to Bhagwati, distortions found in the absence of non-pecuniary externalities can arise from market imperfections or from misguided policy interventions which are exogenously set. In both cases, well-designed and targeted policies could avoid the distortion. In this paper, we point out that asymmetric information creates a new fundamental source of distortions. Information asymmetries impose incentive compatibility constraints on policy instruments which necessarily leave some distortionary behavior in the economy.

This last point is in fact closely related to some recent works by Guesnerie (1998) and (2001), Spector (2001), Naiko (1996), and Gabaix (1997a and 1997b). This burgeoning literature investigates also how asymmetric information imposes limits on domestic redistributive policies and prevents the separation between "efficiency" and "equity" considerations. Extending the non-linear income taxation framework developed by Stiglitz (1982) for a closed economy to a 2×2 trade model, these papers show that, laissez-faire can be socially inferior, at least locally, to autarky. In these papers, the demand side of the economy has private knowledge on the source of factor income (skill versus unskilled labor income) and incentive compatibility constraints affect the trade-off between consumption and leisure. Our approach investigates instead informational asymmetries which are related to the production side of the economy. Also, for a simple parametric form of utility and production functions, we provide a global characterization of the conditions under which *"free trade cum optimal domestic regulation"* dominates or is dominated by *"autarky cum optimal domestic regulation"*.

This paper builds also to a large extend on the optimal regulation literature developed by Baron and Myerson (1982) and Laffont and Tirole (1993) among others. An important lesson of these works is that, under asymmetric information, policy intervention no longer achieves an efficient outcome even when instruments are unrestricted. There remains a fundamental trade-off between giving up to regulated firms information rents which are socially costly and reaching allocative efficiency. That literature is definitively cast in a partial equilibrium framework. We embed such a regulation framework in a standard general equilibrium of trade. This leads us to stress that information rents, even though they prevent from reaching an efficient outcome, play also a role in redistributing wealth in the economy. We analyze the impact of that costly redistribution on prices and trade patterns.

Lastly, in the recent years, there has been a renewed interest in the study of the links between the internal organization of firms and the pattern of international trade of a country. Motivated by the noticeable contemporary wave of outsourcing, interna-

[2] See Srinavasan (1987) for instance.

tional fragmentation and corporate hierarchical flattering,[3] several papers have started to analyze the links between market competition and globalization on the one hand, and contractual modes between and within firms on the other hand (Mac Laren (1999), Grossman and Helpman (2002), Marin and Verdier (2001, 2002a, 2002b), Puga and Trefler (2002)). Following Williamson (1975), this literature has stressed the importance of the "hold-up" problem and of the cost of delegation between various contractual partners involved in the production and trade process to explain the boundaries of the international firm. One major achievement of that line of research is to derive implications of globalized markets for the incentives to organize production either in-house or through domestic and international outsourcing. At a broad level, we share with this literature some concerns for looking at how contracting problems affect the pattern of trade. At a more detailed level, our approach is quite different. Instead of considering incomplete contracting environments, we focus on asymmetric information as the sole source of contractual problems. This setting is then more easily amenable to the normative analysis which is the core of this paper. Instead of focusing on the boundaries of the international firm, we will also stress the allocative and redistributive consequences of agency problems between firms and their regulating governments for the patterns of trade.

Section 2 describes both the partial and general equilibrium sides of the economy. Section 3 discusses the benchmark economy without asymmetric information. Section 4 considers the case of an economy with agency costs. It starts with a characterization of the autarkic equilibrium and follows with a characterization of how the structure of comparative advantages of the small open economy is affected by informational asymmetries. Section 5 considers the normative implications of openness. Section 6 concludes. Proofs are relegated to an Appendix.

2 The Model

The model has two building blocks: trade between a small country and the rest of the world and regulation within that country. On the trade side, we consider a standard Hecksher-Ohlin model with two final goods, manfufactures M and agricultural products A and two factors of production, labor and capital. On top of these standard features, we add a continuum of intermediate sectors run by monopolies which use only labor as an input.

In those monopolistic sectors, production technologies are highly idiosyncratic and owners of those monopolies have private information on those technologies. Domestic regulation is thus called for to limit monopoly power. This intervention is nevertheless

[3] See Feenstra (1998).

constrained by the fact that regulators do not have complete knowledge of all the relevant information.

We analyze each of these two building blocks in turn and we describe the equilibrium under autarky. Then, we will be interested in the role of market openness on the pattern of international trade.

• **Preferences:** To simplify the analysis and get a tractable model, we assume that consumers have preferences over consumption of the two final goods M and A given by a standard Cobb-Douglas utility function:

$$U(C_M, C_A) = C_M^{\alpha} C_A^{1-\alpha}, \quad \text{where} \quad \alpha < 1.$$

• **Final Good Sectors:** The two final consumption goods M and A are produced by competitive sectors. We denote by P_M and P_A their respective prices. Both sectors use a continuum of intermediate non-tradable inputs and some production factors. In line with standard trade factor endowment theory, we assume that sector M is capital intensive while sector A is labor intensive. More precisely, the production functions is each sector are respectively given by

$$Y_M = D_M^{\beta} K^{1-\beta}, \quad \text{and} \quad Y_A = D_A^{\beta} L^{1-\beta},$$

where $\beta \in)0,1($ and $D_i = \left(\int_0^1 x_{ji}^{\frac{\sigma-1}{\sigma}} dj\right)^{\frac{\sigma}{\sigma-1}}$ with $\sigma > 1$ for $i = M, A$. The amount of intermediate good j used in sector i is denoted by x_{ji}. j is an index which varies continuously on $[0,1]$. σ is the elasticity of substitution between any two intermediate goods in the production process of good i. With such a formulation, all non-tradable intermediate inputs enter symmetrically in the production of the tradable sectors.[4] To fix ideas, one can think of those non-tradable inputs as major services like electricity, telecommunication, transportations which are produced locally, regulated, and (in first approximation) not traded in international markets.

We denote by r the rental rate of capital and w the labor wage. Profits in each final good sector can be written as:

$$\Pi_M = P_M \left(\int_0^1 x_{jM}^{\frac{\sigma-1}{\sigma}} dj\right)^{\frac{\beta\sigma}{\sigma-1}} K^{1-\beta} - rK - \int_0^1 t_{jM} dj,$$

and

$$\Pi_A = P_A \left(\int_0^1 x_{jM}^{\frac{\sigma-1}{\sigma}} dj\right)^{\frac{\beta\sigma}{\sigma-1}} L^{1-\beta} - wL - \int_0^1 t_{jA} dj,$$

[4] Breaking this symmetry leads to a more complex analysis without changing the main insights of the paper.

where t_{jM} and t_{jA} are the price paid by the final good sectors to intermediate sectors to obtain the inputs needed in their production processes.[5]

Finally, this economy is endowed with respectively $\bar{L}$ and $\bar{K}$ units of labor and capital.

• **Intermediate Sectors:** Producting x_j units of intermediate good j requires $\theta_j x_j$ units of labor. The productivity of each intermediate sector j is affected by the realization of a random shock θ_j. These shocks are independently and identically distributed on $\Theta = \{\underline{\theta}, \bar{\theta}\}$ with respective probabilities ν and $1-\nu$. Probabilities are common knowledge. We denote $\underset{\theta}{E}(\cdot)$ the expectation operator with respect to θ.

Production shocks in sector j are observed only by the owners of firm j. This assumption is motivated by the fact that the technology for each intermediate sector is highly specific to that sector and cannot be easily compared with other intermediate inputs' technologies by firms in the final sectors.[6]

Monopoly in the intermediate sectors requires regulatory policies designed to curb market power and improves allocative efficiency. Of course, asymmetric information in those sectors will be an obstacle to an efficiency regulation and this obstacle creates important trade-offs between allocative efficiency and extraction of the monopolies' information rents.

Profits in the regulated sector j can be written as:

$$U_j = t_{jM} + t_{jA} - w\theta_j(x_{jM} + x_{jA}), \qquad \text{for } j \in [0,1].$$

Of course, firms must generate a positive profit and that condition gives a lower bound on U_j.

The regulator's objective is to ensure that intermediate sectors charge a price equal to marginal cost without giving up too much information rent to the owners of those intermediate sectors. He is only concerned by the profits in the final sectors and he maximizes the following objective function

$$W = \Pi_M + \Pi_A.$$

Expressing profits in the final sector as a function of the information rents of the

[5] Those prices are not necessarily linear in the quantity bought. Typically, under regulation, those prices are regulated and the optimal regulation does not correspond to such linear prices.

[6] Of course, the reader may found our representative customer a little bit schizophrenic. On the one hand, as an owner of the intermediate sectors, he is privately informed on the shocks hitting these sectors. On the other hand, as an owner of the firms in the final sector, he is not aware of this piece of information. This modeling difficulty could be easily avoided by having different classes of owners having the same Cobb-Douglas utility function. Then, using Gorman aggregation rule it is standard to show that the behavior of those agents can be aggregated and summarized by the behavior of an agent having the whole wealth of the economy.

intermediate ones, this objective function can be rewritten as :

$$\underbrace{P_M\left(\int_0^1 x_{jM}^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{\beta\sigma}{\sigma-1}}K^{1-\beta}+P_A\left(\int_0^1 x_{jA}^{\frac{\sigma-1}{\sigma}}dj\right)^{\frac{\beta\sigma}{\sigma-1}}L^{1-\beta}-rK-w\left(\int_0^1\theta_j(x_{jM}+x_{jA})dj+L\right)}_{\text{Allocative Efficiency}}$$

$$-\underbrace{\int_0^1 U_j dj}_{\text{Information Rents}}.$$

This expression stresses the trade-off faced by the regulator. On the one hand, the regulator is concerned by an efficient use of resources, namely finding the vector of inputs (K, L, x_{jM}, x_{jA}) which maximizes aggregated profits in the whole production sector (first bracketed term). On the other hand, the regulator is also interested in minimizing the information rents left to the intermediate sectors.

It should be stressed that the regulator is only concerned by profits is the final sectors. Our approach could nevertheless be extended, at the cost of an increased complexity, to the case where a positive, but less than one, weight is given to the intermediate sectors in the regulator's objective.[7] The specific objective we have chosen is thus such that everything happens as if the incentive contracts of the intermediate sectors were offered by the producers in the final sectors themselves. This interpretation of the model again broadens the scope of our analysis.

Finally, it should also be noticed that our concept of regulation is rather partial. Regulation controls for monopoly power in each intermediate sector but does not rule the whole economy through a comprehensive grand-contract as in a planified economy. This assumption corresponds better to regulatory policies used in practice for intermediate goods like electricity telecommunication or transports. There is still significant scope for markets and prices to equilibrate aggregate supply and demand in the economy even after regulatory tools have been set up.

3 Benchmark: Complete Information

Let us start by investigating the case of complete information. This will provide a useful benchmark against which one can assess the importance of agency costs and their impact on the pattern of trade

• **Supply Side:** Suppose that the regulator is fully informed on the whole vector of shocks $\vec{\theta} = (\theta_1, \ldots, \theta_j, \ldots)$ hitting all intermediate sectors. Given that there is a continuum of

[7] See Baron and Myerson (1982) for that assumption in a partial equilibrium model.

symmetric intermediate sectors, the Law of Large Number applies and we have:

$$D_i = \left[\int_0^1 x_{ji}^{\frac{\sigma-1}{\sigma}} dj\right]^{\frac{\sigma}{\sigma-1}} = \left(\underset{\theta}{E}\left(x_{ji}(\theta)^{\frac{\sigma-1}{\sigma}}\right)\right)^{\frac{\sigma}{\sigma-1}}$$

where x_{ji} is the output of the intermediate goods j for sector i when the productivity shock hitting these intermediate sectors is θ. Of course, because of symmetry, all sectors produce the same outputs in equilibrium when they are hit the same way and the indice j can be omitted so that we can denote $x_{ji}(\theta) = x_i(\theta)$ for any θ. Similarly, we also denote by $U(\theta)$ the profits or information rents of a given intermediate sector in state θ.

Under complete information, the regulator's problem is thus given by:

$$\max_{\{K,L,x_i(\cdot),U(\cdot)\}} P_M\left(\underset{\theta}{E}\left(x_M(\theta)^{\frac{\sigma-1}{\sigma}}\right)\right)^{\frac{\beta\sigma}{\sigma-1}} K^{1-\beta} + P_A\left(\underset{\theta}{E}\left(x_A(\theta)^{\frac{\sigma-1}{\sigma}}\right)\right)^{\frac{\beta\sigma}{\sigma-1}} L^{1-\beta}$$
$$-rK - wL - w\underset{\theta}{E}\left(\theta(x_M(\theta) + x_A(\theta))\right) - \underset{\theta}{E}(U(\theta))$$

subject to

$$U(\theta) \geq 0, \text{ for all } \theta \text{ in } \Theta, \tag{1}$$

where (**??**) are the participation constraints of the monopolies.

Solving this problem is straightforward and defines the supply side of our economy under complete information.

Proposition 1 *: Under complete information, the optimal regulation of the intermediate sectors is such that:*

• *The relative price of consumption goods $p = \frac{P_M}{P_A}$ and the relative factor price $\omega = \frac{w}{r}$ satisfy:*

$$p = \omega^{-(1-\beta)}. \tag{2}$$

Taking the manufactured good as the numeraire (i.e. $P_M = 1$), we have also

$$r^{1-\beta}w^{\beta} = (1-\beta)^{1-\beta}\beta^{\beta}\Theta^{-\beta}, \tag{3}$$

where $\Theta = \left(\underset{\theta}{E}(\theta^{1-\sigma})\right)^{\frac{1}{1-\sigma}}$ is an aggregate productivity index.

• *Production levels of intermediate goods in both sectors are respectively given by:*

$$x_M(\theta) = \theta^{-\sigma}\Theta^{\frac{-1+\sigma-\beta\sigma}{1-\beta}} K\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}$$

and

$$x_A(\theta) = \theta^{-\sigma}\Theta^{\frac{-1+\sigma-\beta\sigma}{1-\beta}} L\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}. \tag{4}$$

• *For any realization of the productivity shock, owners of firms in the intermediate sectors gets zero information rent, $U^{FI}(\theta) = 0$, for all θ in Θ.*

Under complete information, the optimal regulatory policy on the supply side of the economy maximizes the whole profit of the vertically integrated structure obtained by merging final and intermediate sectors. Everything happens as if intermediate sectors were selling their inputs at marginal cost to final good producers and zero profit was made by these intermediate sectors. Because of constant returns to scale, the whole profit of this integrated structure will also be zero.

It should be stressed that firms in the intermediate sectors produce more when they are hit by a good shock $\underline{\theta}$ than by a bad shock $\bar{\theta}$. Accordingly, we shall refer in the sequel to the efficient (resp. inefficient) firm $\underline{\theta}$ (resp. $\bar{\theta}$).

Importantly, (**??**) defines a downward sloping curve, $r = r_1^{FI}(w)$. Indeed, this condition ensures that the integrated structure makes zero profit because of constant returns to scale. A higher wage must be compensated by a lower rental cost of capital to do so. In what follows, we will sometimes refer to that curve as the *zero profit locus*.

It is already worth noticing that Θ can be viewed as an aggregate productivity index of this economy. As the productivity index Θ increases, production of intermediate goods out of labor becomes more difficult. This decreases the demand for complementary inputs, capital and labor emanating from the final goods sectors.

• **Demand Side:** Let us now turn to the demand side of the economy. Given Cobb-Douglas preferences for the representative consumer, demands for both consumption goods are given by

$$C_M = \frac{\alpha R}{P_M} \quad \text{and} \quad C_A = \frac{(1-\alpha)R}{P_A},$$

where R is the consumer's total income.

• **Autarky Equilibrium:** Given that the supply side of the economy produces under constant returns to scale, R reduces to the factor endowments income of this economy, namely $R = w\bar{L} + r\bar{K}$. Under autarky, the equilibrium condition of the market for manufactured good yields:

$$\frac{\alpha}{P_M}(w\bar{L} + r\bar{K}) = Y_M = K\left(\frac{\beta P_M}{w}\right)^{\frac{\beta}{1-\beta}} \Theta^{\frac{-\beta}{1-\beta}},$$

where $K = \bar{K}$ from equilibrium in the domestic capital market.

Finally, using (**??**), we get the relationship:

$$\frac{\alpha}{P_M}(w\bar{L} + r\bar{K}) = \frac{r\bar{K}}{(1-\beta)P_M}$$

or

$$\frac{r}{w} = \frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)} - 1\right)}. \tag{5}$$

Market clearing conditions for the manufactured good and capital define then an upward slopping relationship $r = r_2^{FI}(w)$ linking the rental rate of capital and the labor wage: *the equilibrium locus.* The relative factor price ω is inversely proportional to the relative endowment of factors. As capital in the economy becomes more scarce, the rental rate of capital appreciates in relative terms.

An *autarky equilibrium* is finally obtained when (**??**), (**??**) and (**??**) hold altogether.

Proposition 2 *: There always exists a unique equilibrium under autarky and complete information. It is characterized by the price system $(P_M^{FI} = 1, P_A^{FI} = \frac{1}{p}, w^{FI}, r^{FI})$ solving (**??**) to (**??**).*

As the productivity index Θ increases, the zero profit locus $r_1^{FI}(\cdot)$ is shifted downwards and the equilibrium locus $r_2^{FI}(\cdot)$ remains unchanged. There is a downward shift in the factor prices w^{FI} and r^{FI}.

It is important to note that, as the productivity index deteriorates (Θ getting larger), the demand for intermediate inputs decreases and, by complementarity, factor demands for both capital and labor diminish. This leads to a lower rental price of capital and lower wages. See Figure 1. Since intermediate sectors enter in the same way in the production technologies of both tradable sectors, the whole impact of a change in the productivity index is captured by the zero profit locus (**??**). When the productivity index increases, the equilibrium locus (**??**) is unchanged and the relative factor price remains the same, namely $\omega^{FI} = \frac{\bar{K}}{\bar{L}}\left(\frac{1}{\alpha(1-\beta)} - 1\right)$. In the sequel, we will be particularly interested in the impact of asymmetric information on the productivity index.

• **Free Trade:** For the sake of completeness, let us now consider the case where this small country is opened up to international trade with the rest of the world. Under free trade, the relative price of final goods is fixed on the world market at some exogenous level $\hat{p} = \frac{P_M}{P_A}$.

Note that (**??**) and (**??**) are still valid and, given the normalization $P_M = 1$, all remaining prices in the open economy are completely defined.

Two cases must be distinguished:

• $\hat{p} > p^{FI} = \omega^{FI^{-(1-\beta)}}$. Then the relative world price between the two final goods is greater than its value under autarky. The small country is relatively well endowed with capital and less well endowed with labor. The country exports the capital intensive final good and imports the other labor intensive final good. An increase in the world price of the capital intensive final good increases the demand for capital of that sector and raises the rental rate of capital above its autarky level. At the same time, the wage rate decreases to guarantee zero profit in the final sectors under constant returns to scale. Equilibrium factor prices are such that:

$$\hat{w} < w^{FI} \qquad \text{and} \qquad \hat{r} > r^{FI}.$$

• $\hat{p} < p^{FI} = \omega^{FI^{-(1-\beta)}}$. The relative price of the final good is lower than its value under autarky. This arises when the small country is poor in capital and rich in labor. By a symmetric token, we get that:

$$\hat{w} > w^{FI} \qquad \text{and} \qquad \hat{r} < r^{FI}.$$

Figure 1 summarizes graphically the two cases.

It is then easy to check that free-trade always Pareto dominates autarky under complete information. With our Cobb-Douglas preferences, the indirect utility function of the representative consumer writes as:

$$V(p,R) = \alpha^{\alpha}(1-\alpha)^{1-\alpha}\frac{R}{p^{\alpha-1}}$$

with $p = \frac{P_M}{P_A} = \frac{1}{P_A}$ (using again the normalization $P_M = 1$) and where total income endowment is:

$$R = w\bar{L} + r\bar{K} = \beta^{\beta}(1-\beta)^{1-\beta}\Theta^{-\beta}\left(\frac{\bar{L}}{p} + p^{\frac{\beta}{1-\beta}}\bar{K}\right).$$

The consumer's indirect utility function can finally be expressed as:

$$V(p) = \alpha^{\alpha}(1-\alpha)^{1-\alpha}\beta^{\beta}(1-\beta)^{\beta}\Theta^{-\beta}\left(\frac{\bar{L} + p^{\frac{1}{1-\beta}}\bar{K}}{p^{\alpha}}\right).$$

Since, we have

$$\frac{1}{V}\frac{dV}{dp} = -\frac{\alpha}{p} + \frac{1}{1-\beta}\frac{p^{\frac{\beta}{1-\beta}}\bar{K}}{\bar{L} + p^{\frac{1}{1-\beta}}\bar{K}},$$

$V(\cdot)$ is U-shaped and minimized for $p = \left[\frac{\bar{L}}{\bar{K}}\frac{1}{\frac{1}{\alpha(1-\beta)}-1}\right]^{1-\beta} = p^{FI}$ where indeed p^{FI} is the autarkic equilibrium price of the benchmark economy with complete information. Therefore, free trade is always welfare superior.

4 Asymmetric Information

Let us now introduce asymmetric information and suppose that owners of firms in the intermediate sectors are privately informed on productivity shocks.

• **Supply Side:** The productivity shocks in any intermediate sector remain unobserved by the regulator. The regulator has to rely on an incentive regulatory scheme to induce firms to truthful reveal their productivity parameter.

>From the Revelation Principle such an incentive scheme stipulates how much each intermediate sector has to produce as a function of its announcements on its efficiency parameter. In full generality, the transfer t_j and the output x_j in sector j must depend on the whole announcement $\hat{\vec{\theta}}$ made by each sector. Given that there is a continuum of symmetric intermediate sectors with i.i.d. shocks, we will use the Law of Large Numbers to approximate the optimal contract by a vector of contracts for each sector which depends only on the announcement of that sector. Typically, a multilateral contract with all sectors is thus a collection of bilateral contracts with each sector which take the form $\{t(\hat{\theta}), x(\hat{\theta})\}$ where $\hat{\theta}$ is the announced productivity parameter in that sector only, $t(\hat{\theta})$ and $x(\hat{\theta})$ being respectively the payment and the production of that sector.

Still, using symmetry among all sectors, incentive compatibility is ensured when the following constraints hold:

$$U(\underline{\theta}) \geq t_M(\bar{\theta}) + t_A(\bar{\theta}) - w\underline{\theta}\left(x_M(\bar{\theta}) + x_A(\bar{\theta})\right) = U(\bar{\theta}) + w\Delta\theta\left(x_M(\bar{\theta}) + x_A(\bar{\theta})\right), \tag{6}$$

and

$$U(\bar{\theta}) \geq t_M(\underline{\theta}) + t_A(\underline{\theta}) - w\bar{\theta}\left(x_M(\underline{\theta}) + x_A(\underline{\theta})\right) = U(\underline{\theta}) - w\Delta\theta\left(x_M(\underline{\theta}) + x_A(\underline{\theta})\right). \tag{7}$$

It is a standard result in the incentive literature[8] that the binding incentive constraint at the optimum of the regulator's problem is that of the most efficient firm $\underline{\theta}$, namely (**??**) whereas the binding participation constraint is that of the inefficient firm, i.e.,

$$U(\bar{\theta}) \geq 0. \tag{8}$$

Under asymmetric information, the regulator's problem becomes:

$$\max_{\{K,L,x_i(\cdot),U(\cdot)\}} P_M\left(\underset{\theta}{E}\left(x_M(\theta)^{\frac{\sigma-1}{\sigma}}\right)\right)^{\frac{\beta\sigma}{1-\sigma}} K^{1-\beta} + P_A\left(\underset{\theta}{E}\left(x_A(\theta)^{\frac{\sigma-1}{\sigma}}\right)\right)^{\frac{\beta\sigma}{1-\sigma}} L^{1-\beta}$$
$$-rK - wL - w\underset{\theta}{E}\left(\theta(x_M(\theta) + x_A(\theta))\right) - \underset{\theta}{E}(U(\theta))$$

subject to (**??**) and (**??**).

Of course, the last two constraints are binding at the optimum since information rents in intermediate sectors are perceived as socially costly. Agency costs take then the simpler form:

$$\underset{\theta}{E}(U(\theta)) = w\nu\Delta\theta\left(x_M(\bar{\theta}) + x_A(\bar{\theta})\right).$$

Inserting this expression into the regulator's problem, one can easily see that everything happens as if that problem was the same as under complete information with the

[8] See Laffont and Martimort (2002, Chapter 2) for instance.

only change coming from the fact that the true productivity parameter $\bar{\theta}$ is now replaced by a virtual parameter $\tilde{\bar{\theta}} = \bar{\theta} + \frac{\nu}{1-\nu}\Delta\theta$ which is greater whereas the virtual productivity $\tilde{\underline{\theta}}$ remains equal to the true productivity parameter $\underline{\theta}$.

As a result, we can directly import formula from Proposition **??** to characterize the supply side of this economy.

Proposition 3 *: Under asymmetric information, the optimal regulation of the intermediate sectors entails:*

• *(**??**) still holds and (**??**) is replaced by (**??**):*

$$r^{1-\beta}w^{\beta} = (1-\beta)^{\beta}\beta^{\beta}\tilde{\Theta}^{-\beta}, \tag{9}$$

where $\tilde{\Theta}$ is the virtual productivity index $\tilde{\Theta} = \left(E(\tilde{\theta}^{1-\sigma})\right)^{\frac{1}{1-\sigma}}$ which is greater than the true productivity index.

• *The productions of intermediate goods in both sectors are respectively given by:*

$$x_M(\theta) = \tilde{\theta}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}K\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}} \quad \text{and} \quad x_A(\theta) = \tilde{\theta}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}L\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}.$$

• *Owners of a monopoly in any intermediate sector get a positive information rent if and only if the firm is hit by a good productivity shock $\underline{\theta}$; $U(\underline{\theta}) = w\Delta\theta(x_M(\bar{\theta}) + x_A(\bar{\theta}))$, and $U(\underline{\theta}) = 0$.*

Under asymmetric information, the regulator wants to reduce the incentives of any monopoly to report being less efficient than what it really is. Indeed, to induce participation by the least efficient firm $\bar{\theta}$, the regulator must increase the price paid by the final goods sectors for the inputs produced by these firms. This increases the incentives of an efficient firm to pretend being less efficient. If it does so, it can produce the same output by using less labor and benefitting from the high price offered to the inefficient firms. Owners of efficient firms enjoy then a positive information rent as it can be seen from (**??**).

The information rents left to efficient firms in intermediate sectors are costly from the regulator's viewpoint. The regulator can reduce that cost by simply distorting downwards $x_M(\bar{\theta})$ and $x_A(\bar{\theta})$ below their complete information values. That effect is captured by replacing $\bar{\theta}$ and Θ respectively by $\tilde{\bar{\theta}}$ and $\tilde{\Theta}$. Because of asymmetric information, everything happens as if there is now a wedge between the unit price at which inefficient firms can sell their good and their marginal cost. There is an inefficiently low output for those firms. Asymmetric information creates a dead-weight loss in the economy. Moreover, because information rents are proportional to labor wages, the dead-weight loss increases with the wage rate. That effect is particularly important for what follows.

Asymmetric information does not change the relationship between the rental price and labor wage. The zero profit condition for the final sectors yields a curve (**??**) which is still downward slopping as under complete information. We will denote by $r = r_1^{AI}(w)$ this new relationship.

Asymmetric information replaces nevertheless the productivity index by a virtual productivity index which is greater. The curve (**??**) is thus shifted downwards below (**??**), the *zero profit locus* under complete information.

We already know that such a downward shift is associated with lower wage and rental rate of capital. However, this is not the only effect of asymmetric information in a general equilibrium model. Information rents in the intermediate sectors are also redistributed to the representative consumer as an owner of the intermediate sectors. The latter enjoys income flows not only from the standard capital and labor endowments in this economy but from an additional *"informational endowment"*.

• **Demand Side:** Under asymmetric information, the total endowment of the representative consumer writes then as:

$$R = \underbrace{w\bar{L} + r\bar{K}}_{\text{Complete Information Endowment}} + \underbrace{\nu\Delta\theta w(x_M(\bar{\theta}) + x_A(\bar{\theta}))}_{\text{Informational Endowment}},$$

or using the expressions of outputs found in Proposition **??**,

$$\begin{aligned} R &= w\bar{L} + \bar{K}\left(r + \nu\Delta\theta w\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}\tilde{\tilde{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\right) \\ &\quad + \nu\Delta\theta w L\tilde{\tilde{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}} \end{aligned} \tag{10}$$

where the amount of labor L used in the agricultural sector is such that:

$$L = \bar{L} - \underset{\theta}{E}\left(\theta(x_M(\theta) + x_A(\theta))\right). \tag{11}$$

Inserting the expressions of outputs into (**??**) yields a simple expression of R (thanks to the Cobb-Douglas specification):

$$R = (w\bar{L} + r\bar{K})\left(1 + \frac{\mu\lambda}{1+\mu}\right)$$

where $\lambda = \frac{\nu\Delta\theta\tilde{\tilde{\theta}}^{-\sigma}}{\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\tilde{\theta}}^{1-\sigma}}$ and $\mu = \frac{\beta}{1-\beta}\left(\frac{\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\tilde{\theta}}^{1-\sigma}}{\nu\underline{\theta}^{1-\sigma}+(1-\nu)\tilde{\tilde{\theta}}^{1-\sigma}}\right)$.

Everything happens thus as if, because of his informational endowment, the true income perceived by the representative customer was *scaled up* under asymmetric information.

4.1 Autarky Equilibrium

We are now ready to characterize equilibrium prices in the closed economy. Under autarky, market clearing conditions for manufacturing and capital yield:

$$\frac{\alpha R}{P_M} = Y_M = \bar{K}\left(\frac{\beta P_M}{w}\right)^{\frac{\beta}{1-\beta}} \tilde{\Theta}^{\frac{-\beta}{1-\beta}}. \tag{12}$$

We prove in the Appendix that the market equilibrium equation can be rewritten as

$$\alpha(w\bar{L} + r\bar{K})\left(1 + \frac{\mu\lambda}{1+\mu}\right) = \frac{r\bar{K}}{1-\beta}, \tag{13}$$

or to put it differently

$$\frac{r}{w} = \frac{\bar{L}}{\bar{K}}\left(\frac{1 + \frac{\mu\lambda}{1+\mu}}{\frac{1}{\alpha(1-\beta)} - \left(1 + \frac{\mu\lambda}{1+\mu}\right)}\right). \tag{14}$$

For the rest of the paper, we will assume that the following condition holds

$$\frac{1}{\alpha(1-\beta)} > 1 + \frac{\mu\lambda}{1+\mu}. \tag{15}$$

That condition guarantees that the denominator of (**??**) remains positive. It is satisfied when $\Delta\theta$ is small enough, i.e., when adverse selection is not too important.[9] When (**??**) holds, the market equilibrium equation (**??**) still defines, as under complete information, an upward sloping relationship $r = r_2^{AI}(w)$ between the wage rate and the rental rate of capital.

Importantly, $r_2^{AI}(\cdot)$ is always above $r_2^{FI}(\cdot)$. The intuition is again straightforward and comes from a careful analysis of the supply and demand curves on the market for the manufactured good.

First, because the representative consumer owns also the intermediate sectors, he benefits from the information rents associated to those sectors. This extra income increases the demand for both final goods. Given the Cobb-Douglas preferences, both demands increase by the same proportion. This income effect is captured by the scale factor $\left(1 + \frac{\mu\lambda}{1+\mu}\right)$ on the l.h.s. of (**??**).

Second, asymmetric information affects also a priori the supply of manufactured good. On the one hand, intermediate goods becomes more costly and these sectors use less labor. In equilibrium, wages go down. That general equilibrium effect in turn boosts the production level of intermediate inputs. In equilibrium, it turns out that the fall in production due to asymmetric information is fully offset by this wage decrease. The production of the

[9] If (**??**) does not hold, asymmetric information destroys the competitive equilibrium.

manufactured sectors and the demand for capital remains as under complete information. That effect is captured on the r.h.s. of (**??**) which captures the revenue of the manufactured sector which remains unchanged. Those income and production effects result in an increase of the relative price of capital r/w.

We can now complete the description of our autarkic equilibrium.

Proposition 4 *: Assume that condition (**??**) holds, then there always exists a unique equilibrium under autarky and asymmetric information. It is characterized by the price system* $(P_M^{AI} = 1, P_A^{AI} = \frac{1}{p}, W^{AI}, r^{AI})$ *solving (**??**), (**??**) and (**??**).*

A priori, it is hard to compare autarky prices under complete and asymmetric information. On the one hand, the downward shift of the zero profit locus (**??**) due to the fall in the productivity index suggests that the equilibrium rental rate and wage are lower under asymmetric information. On the other hand, the upward shift of the market equilibrium curve suggests that the rental rate of capital should also increase. If the total impact of asymmetric information on wage is unambiguous, the impact on rental price depends on the parameter of the model as shown in the proposition below. See also Figure 2.

Proposition 5 *: Under asymmetric information, labor is cheaper than under complete information,* $w^{AI} < w^{FI}$*. Capital is cheaper, i.e.,* $r^{AI} < r^{FI}$*, if and only if:*

$$\frac{\tilde{\Theta}}{\Theta} > \frac{1}{1 - \frac{\mu\lambda}{(1+\mu)\left(\frac{1}{\alpha(1-\beta)} - 1\right)}}. \tag{16}$$

Using Taylor expansions in the limiting case of small degrees of asymmetric information ($\Delta\theta$ small), condition (**??**) becomes

$$1 > \frac{\beta}{(1 - \beta + \nu\beta)\left(\frac{1}{\alpha(1-\beta)} - 1\right)} \tag{17}$$

which is always satisfied since $\alpha < 1$ and $\beta < 1$.

Given that information rents in intermediate sectors are costly for the regulator, strong output distortions in these sectors are necessary and the relative supply curve moves also significantly towards the origin. The rental price of capital may end up being lower than under complete information. This is particularly true when α is sufficiently small as it can be seen on (**??**). In such a case, the market equilibrium locus $r_2(\cdot)$ is almost vertical since consumers spend almost none of their income on the capital intensive good. Changes in market prices are essentially fully explained by changes in the productivity index.

4.2 Free Trade

Under free trade, the relative price of consumption goods is again fixed on the world market at an exogenous value $\hat{p} = \frac{P_M}{P_A}$. Following the same logic as under complete information, the pattern of trade can be immediately derived and depends on whether $\hat{p}$ is above the relative price under autarky p^{AI} or not.

In fact, the relative price of the final goods under autarky increases with asymmetric information since:

$$p^{AI} = \left(\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)} - 1 - \frac{\mu\lambda}{1+\mu}\right)} \right)^{1-\beta} > p^{FI} = \left(\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)} - 1\right)} \right)^{1-\beta}.$$

Since asymmetric information contracts intermediate sectors which use labor as an input, more labor becomes available for the labor intensive final good which becomes cheaper. As a result, the relative price between the two final goods p increases with respect to its complete information value.

Finally, we can state the following.

Proposition 6 *: Assume that $p^{AI} > \hat{p} > p^{FI}$, then under complete information, the small economy expands its production of the capital intensive good and contracts that of the labor intensive one whereas it is the reverse under asymmetric information.*

Asymmetric information may change the pattern of comparative advantage in the economy. To better understand this result, it is useful to come back on the definition of p^{AI} and rewrite it as follows:

$$p^{AI} = \left(\frac{\widetilde{\left(\frac{\bar{L}}{\bar{K}}\right)}}{\frac{1}{\alpha(1-\beta)} - 1} \right)^{1-\beta}.$$

That expression highlights that, under asymmetric information, the relative factor endowment $\frac{\bar{L}}{\bar{K}}$ of the economy has to be replaced by its *virtual* value, namely:

$$\widetilde{\left(\frac{\bar{L}}{\bar{K}}\right)} = \frac{\frac{\bar{L}}{\bar{K}}}{\left(1 - \frac{\mu\lambda}{(1+\mu)\left(\frac{1}{\alpha(1-\beta)} - 1\right)}\right)} > \frac{\bar{L}}{\bar{K}}.$$

With asymmetric information, everything happens thus as if the small country was relatively richer in the factor which is more intensively used by sectors affected by agency problems. Indeed, since these sectors contract their activity, labor is relatively cheaper and, as a result, the small country specializes more easily in the labor intensive good. Asymmetric information (even with optimal regulation) introduces therefore a specialization bias.

5 Normative Analysis of Openness

In the present context with agency costs, it is interesting to see how the traditional normative conclusions of international trade and openness are affected. Given that we are in a second-best world characterized by regulated monopolistic power and asymmetric information, the standard normative theorems of international trade need not apply. One should not always expect free trade to be necessarily welfare improving even for a small open economy.

Inserting into the indirect utility function of the representative consumer the new value taken by R under asymmetric information, namely

$$R = (w\bar{L} + r\bar{K})\left(1 + \frac{\mu\lambda}{1+\mu}\right) = \beta^{\beta}(1-\beta)^{1-\beta}\tilde{\Theta}^{-\beta}\left(\frac{\bar{L}}{p} + p^{\frac{\beta}{1-\beta}}\bar{K}\right)\left(1 + \frac{\mu\lambda}{1+\mu}\right),$$

we get the consumer's indirect utility function expressed as a function of p only:

$$\tilde{V}(p) = \alpha^{\alpha}(1-\alpha)^{1-\alpha}\beta^{\beta}(1-\beta)^{\beta}\tilde{\Theta}^{-\beta}\left(\frac{\bar{L} + p^{\frac{1}{1-\beta}}\bar{K}}{p^{\alpha}}\right)\left(1 + \frac{\mu\lambda}{1+\mu}\right).$$

Since, we have

$$\frac{1}{\tilde{V}}\frac{d\tilde{V}}{dp} = -\frac{\alpha}{p} + \frac{1}{1-\beta}\frac{p^{\frac{\beta}{1-\beta}}\bar{K}}{\bar{L} + p^{\frac{1}{1-\beta}}\bar{K}},$$

$\tilde{V}(\cdot)$ is U-shaped and again minimized for $p = \left[\frac{\bar{L}}{\bar{K}}\frac{1}{\frac{1}{\alpha(1-\beta)}-1}\right]^{1-\beta} = p^{FI}$ just as in the benchmark economy with complete information. The shape of the indirect utility function of the representative consumer under asymmetric information is then represented in Figure 3.[10] Let $\hat{p}$ then be the international relative price P_M/P_A. Given that $p^{AI} > p^{FI}$, the following proposition follows immediately:

Proposition 7

1. *Free trade is always welfare improving on autarky under full information.*

2. *Under asymmetric information, there is a threshold value p^* such that $p^* < p^{FI}$ and:*

[10] That the indirect utility functions under complete and asymmetric information are both minimized at p^{FI} comes from the fact that the revenu under asymmetric information is scaled up with Cobb-Douglas preferences.

– *if* $\hat{p} \leq p^*$, *free trade is welfare improving on autarky,*

– *if* $p^* < \hat{p} < p^{AI}$, *free trade is welfare worsening on autarky,*

– *if* $p^{AI} \leq \hat{p}$, *free trade is welfare improving on autarky.*

The intuition for this proposition is quite simple. The first part says that, under complete information, one finds back the traditional result that, taking care of the optimal regulation of domestic monopoly power, free trade is Pareto superior to autarky for a small economy. Though the intermediate sectors are run by monopolies, these firms are optimally regulated and therefore those sectors are not the source of any distortion in the economy. After openness, regulators can readjust optimally their regulatory policies towards intermediate sectors, and, not surprisingly, this ensures that the gains of trade with the rest of the world are realized.

Things are rather different in the case of asymmetric information, even though regulation is still optimally adjusted to changes in the world price. Indeed, to minimize information rents, optimal regulation contracts the output intermediate sectors. If openness induces a pattern of specialization which reinforces this domestic distortion, then the additional distortionary effect may offset the traditional gains of trade. A free trade regime is eventually Pareto inferior to autarky.

When $\hat{p} < p^{AI}$, the domestic economy has a comparative advantage in the labor intensive tradable agricultural good. Free trade induces specialization in that sector. By increasing labor demand, this production shift increases the labor wage and reduces output in the intermediate good sectors. This pattern of specialization exacerbates the initial downward output distortion of the intermediate sectors due to asymmetric information. The additional social cost of that change has to be evaluated against the traditional gains from trade in production and consumption of the Hecksher-Ohlin framework. When the international price level is low enough, $\hat{p} \leq p^*$, the gains from trade are big enough and free trade dominates autarky. When however $p^* < \hat{p} < p^{AI}$, the distortion cost associated with specialization in the labor intensive good outweights the usual gains from trade and free trade is welfare reducing. Interestingly, in the region where asymmetric information changes the pattern of comparative advantages in the economy (i.e., when $p_A^{FI} < \hat{p} < p^{AI}$), free trade is welfare worsening compared to autarky.

When $\hat{p} > p^{AI}$, the economy has a comparative advantage in the capital intensive good M. Free trade then induces specialization in that sector and a reduction of production of the labor intensive good A. This, in turn, expands the intermediate monopolistic sector. This production pattern mitigates the initial downward output distortion due to the existence of agency costs. It improves therefore the allocation of resources in the economy. It follows that, in such a case, free trade generates two sources of social gains:

the usual Hecksher-Ohlin gains from trade and, further, reduced domestic distortions associated with the existence of information rents. Free trade is then always welfare superior to autarky

It is also worth stressing that p^{AI} is closer to p^{FI} as the spread of uncertainty $\Delta\theta$ diminishes. For small degrees of asymmetric information, trade openness is thus very likely to improve welfare, whereas for larger ones, the reverse is more likely to happen.

Proposition **??** shows how far the introduction of agency costs may dramatically change the well-known predictions (positive and normative) of standard trade models. Under complete information, trade openness allows a better specialization of a small country. The increase in income of the production factor intensively used in the export sector more than offset the loss incurred by the production factor intensively used in the import competing sector. As a result, the economy becomes richer and the utility of the representative consumer increases. The key point underlying this result is that any efficiency gain from a better specialization can be passed onto the representative customer. Of course, this requires that there exists no constraint on redistributing wealth between owners of the tradable good who win from trade openness and owners of the sector who lose from it.

The key difference under asymmetric information comes from the existence of a dead-weight loss which makes such redistributive transfers costly. Asymmetric information creates a wedge between price and marginal cost and thus, even though, *in fine*, the representative consumer ends up pocketing both the profits of final good sectors and the information rent of the intermediate ones, the total size of this cake is less than under complete information.

When the relative price of tradable goods p decreases with trade openness, the rest of the world produces relatively easily the capital intensive good, meaning that labor is relatively scarce outside the small economy. With trade openness, the relative price of labor in the small economy increases thus (see (**??**)). Since rents in the intermediate sectors are proportional to that price, the cost of these information rents also increases and the dead-weight loss due to asymmetric information is exacerbated. It is then costly to redistribute fully the gains from trade between owners of the labor intensive good who win from trade openness and those of the capital intensive good who lose from it. Part of those gains are dissipated under the form of the socially costly information rents left to the owners of the intermediate sectors monopolies.

When the efficiency gains from trade are small, that increase in the dead-weight loss dominates the fact that the small economy can expand his supply of the labor intensive tradable good and trade openness is welfare worsening. However, when the relative world price of tradable goods is sufficiently low (i.e., when $\hat{p} < p^*$), the efficiency gains from trade more than outweigh the dead-weight loss. Openness recovers its virtues.

However, when the relative price of tradable goods p increases with trade integration, the rest of the world has a comparative advantage in the labor intensive good, meaning that capital is relatively scarce outside the small economy. Openness depresses the relative price of labor in the small economy, killing two birds with the same stone. It has a positive efficiency impact by allowing a better specialization in the small country. It also makes information rents less costly and diminishes the dead-weight loss due to asymmetric information.

6 Conclusion

This paper has investigated how some standard results from trade theory must be amended under asymmetric information. A laissez-faire regime with optimal domestic regulation may no longer be welfare improving even for a small open country. Moreover, the pattern of comparative advantages of that country may be significantly modified compared with the case of complete information. The normative lessons of free trade may change: trade openness is welfare improving only when it mitigates the distortions due to asymmetric information.

Because asymmetric information creates a wedge between price and marginal cost in regulated sectors, its impact on the gains from trade looks, at a rough level, like what one would obtain if we had instead assumed complete information in this economy but left the intermediate monopolistic sectors unregulated. In that case also, a decrease in the relative world price of the capital intensive good increases also the relative price of labor in the small economy. This in turn increases the dead-weight loss of monopoly pricing and may finally decrease the utility of the representative consumer. It should be nevertheless stressed that those monopoly distortions can be easily avoided by designing a fully informed regulation of those intermediate sectors. Implicit in any such analysis of in the distortions associated to monopoly pricing in intermediate sectors is the idea that the regulator faces constraints in the instruments he has at his disposal. Our framework with asymmetric information clearly endogenizes those constraints and makes a similar point in a less ad hoc model.

Of course, our model could be extended by considering a more symmetric environment with two countries of similar size, each being affected by agency costs. The overall trade pattern will then depend on the factor endowments of those countries but also on the degrees of asymmetric information they face. Even though countries may look quite similar in their endowments, differences in information structures may already be a source of trade. More generally, it appears clearly that the pattern of comparative advantages between those countries might also be significantly affected by asymmetric information. The intuition built in the case of a small economy already suggests that free trade may not be always Pareto improving from the world's viewpoint.

Other extensions of the modeling could include generalizations to different preferences, technologies and information structures. Interestingly, one could also think about departing from our representative consumer assumption and introducing some heterogeneity among factor owners inside the small economy. This would pave the way for a political economy analysis of trade policy issues in a setting where asymmetric information in the source of the stakes that various interest groups may have to resist or not to free trade. We leave those works for future research.

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Appendix

• **Proof of Proposition ??:** First notice that the regulator wants (**??**) to be binding at the optimum because the rents of those intermediate sectors are socially costly. Inserting these values into the maximand and optimizing respectively w.r.t. $x_M(\theta)$, and K yields the following first-order conditions:

$$\beta P_M \tilde{X}_M^{\frac{\beta\sigma}{\sigma-1}-1} K^{1-\beta} x_M^{-\frac{1}{\sigma}}(\theta) = w\theta, \text{ for any } \theta, \tag{A1}$$

where $\tilde{X}_M = \underset{\theta}{E}\left(x_M(\theta)^{\frac{\sigma-1}{\sigma}}\right)$ and

$$(1-\beta) P_M \tilde{X}_M^{\frac{\beta\sigma}{\sigma-1}} K^{-\beta} = r. \tag{A2}$$

>From (**??**), we immediately deduce that:

$$x_M(\theta) = \left(\frac{\beta P_M}{w\theta}\right)^{\sigma} K^{(1-\beta)\sigma} \tilde{X}_M^{\frac{(\beta\sigma-\sigma+1)\sigma}{(\sigma-1)}}. \tag{A3}$$

Finally, $\tilde{X}_M$ is such that:

$$\tilde{X}_M = \left(\frac{\beta P_M}{aw}\right)^{\frac{\sigma-1}{\sigma(1-\beta)}} \left(\underset{\theta}{E}(\theta^{1-\sigma})\right)^{\frac{1}{\sigma(1-\beta)}} K^{\frac{(\sigma-1)}{\sigma}}. \tag{A4}$$

>From (**??**), we also obtain:

$$1 = \left(\frac{(1-\beta)P_M}{r}\right)^{1-\beta} \left(\frac{\beta P_M}{w}\right)^{\beta} \left(\underset{\theta}{E}(\theta^{1-\sigma})\right)^{\frac{\beta}{\sigma-1}}, \tag{A5}$$

which gives (**??**) when $P_M = 1$.

Considering the A sector, and proceeding similarly, we get:

$$x_A(\theta) = \left(\frac{\beta P_A}{w\theta}\right)^{\sigma} K^{(1-\beta)\sigma} \tilde{X}_A^{\frac{(\beta\sigma-\sigma+1)\sigma}{\sigma-1}}, \tag{A6}$$

where

$$\tilde{X}_A = \underset{\theta}{E}\left(x_A(\theta)^{\frac{\sigma-1}{\sigma}}\right) = \left(\frac{\beta P_A}{w}\right)^{\frac{\sigma-1}{\sigma(1-\beta)}} \left(\underset{\theta}{E}(\theta^{1-\sigma})\right)^{\frac{1}{\sigma(1-\beta)}} L^{\frac{\sigma-1}{\sigma}}. \tag{A7}$$

Finally, we have:

$$1 = \left(\frac{(1-\beta)P_A}{w}\right)^{1-\beta} \left(\frac{\beta P_A}{w}\right)^{\beta} \left(\underset{\theta}{E}(\theta^{1-\sigma})\right)^{\frac{\beta}{\sigma-1}}. \tag{A8}$$

This finally yields (**??**).

Using (**??**) and (**??**)on the one hand and (**??**) and (**??**) on the other hand, we also get (**??**).

• **Proof of Proposition ??:** Obvious since $r_1(\cdot)$ is decreasing and $r_2(\cdot)$ is increasing over $[0,\infty[$. For the sake of completeness, note that

$$
\begin{aligned}
r^{FI} &= (1-\beta)^{1-\beta}\beta^{\beta}\Theta^{-\beta}\left[\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)}-1\right)}\right]^{\beta}, \\
w^{FI} &= (1-\beta)^{1-\beta}\beta^{\beta}\Theta^{-\beta}\left[\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)}-1\right)}\right]^{(1-\beta)},
\end{aligned}
$$

and

$$P_A^{FI} = \left(\frac{\bar{K}}{\bar{L}}\left(\frac{1}{\alpha(1-\beta)}-1\right)\right)^{1-\beta}.$$

• **Proof of Proposition ??:** Identical to that of Proposition **??** and thus omitted.

• **Derivation of equation (??):** From (**??**), we get:

$$L = \bar{L} - \left(\underset{\theta}{E}\left(\theta(x_M(\theta)+x_A(\theta))\right)\right).$$

Taking into account that

$$\underset{\theta}{E}(\theta x_M(\theta)) = \left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}} \bar{K}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)$$

and

$$\underset{\theta}{E}(\theta x_A(\theta)) = \left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}} L\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right),$$

we finally get:

$$
\begin{aligned}
& L\left(1+\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)\right) \\
&\quad = \bar{L} - \left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}\bar{K}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right).
\end{aligned}
$$

Inserting into (**??**) yields:

$$
\begin{aligned}
R &= w\bar{L}\left(1+\frac{\nu\Delta\theta\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}}{1+\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}}\right) \\
&+ \left(r+\nu\Delta\theta w\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}\right. \\
&\quad \left.-\frac{\nu\Delta\theta w\tilde{\bar{\theta}}^{-\sigma}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)\tilde{\Theta}^{2\left(\frac{-1+\sigma-\beta\sigma}{1-\beta}\right)}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}}{1+\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)}\right)\overline{K}.
\end{aligned}
$$

Or, after simplifications:

$$
\begin{aligned}
R &= w\bar{L}\left(1+\frac{\nu\Delta\theta\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}}{1+\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}}\right) \\
&+ r\bar{K}\left(1+\frac{\nu\Delta\theta w\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}}{1+\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{-\sigma}\right)\tilde{\Theta}^{\frac{-1+\sigma-\beta\sigma}{1-\beta}}\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}}\right).
\end{aligned} \tag{A9}
$$

Under asymmetric information, (**??**) becomes

$$1=\left(\frac{(1-\beta)P_M}{r}\right)^{1-\beta}\left(\frac{\beta P_M}{w}\right)^{\beta}\tilde{\Theta}^{-\beta}$$

or

$$\left(\frac{\beta P_M}{w}\right)^{\frac{1}{1-\beta}}=\tilde{\Theta}^{\frac{\beta}{1-\beta}}\frac{\beta r}{(1-\beta)w}; \tag{A10}$$

and (**??**) becomes

$$1=\left(\frac{(1-\beta)P_A}{w}\right)^{1-\beta}\left(\frac{\beta P_A}{w}\right)^{\beta}\tilde{\Theta}^{-\beta}$$

or

$$\left(\frac{\beta P_A}{w}\right)^{\frac{1}{1-\beta}}=\tilde{\Theta}^{\frac{\beta}{1-\beta}}\left(\frac{\beta}{1-\beta}\right). \tag{A11}$$

Inserting (**??**) and (**??**) into (**??**) yields:

$$
\begin{aligned}
R &= w\bar{L}\left(1+\frac{\frac{\nu\Delta\theta\beta}{1-\beta}\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\sigma-1}}{1+\frac{\beta}{1-\beta}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{1-\sigma}\right)\tilde{\Theta}^{\sigma-1}}\right) \\
&+ r\bar{K}\left(1+\frac{\frac{\nu\Delta\theta\beta}{1-\beta}\tilde{\bar{\theta}}^{-\sigma}\tilde{\Theta}^{\sigma-1}}{1+\frac{\beta}{1-\beta}\left(\nu\underline{\theta}^{1-\sigma}+(1-\nu)\bar{\theta}\tilde{\bar{\theta}}^{1-\sigma}\right)\tilde{\Theta}^{\sigma-1}}\right).
\end{aligned}
$$

Using (**??**) to rewrite the r.h.s. of (**??**) yields finally (**??**).

• **Proof of Proposition ??:** It follows the same lines as that of Proposition **??**. We have:

$$
\begin{aligned}
r^{AI} &= (1-\beta)^{1-\beta}\beta^{\beta}\tilde{\Theta}^{-\beta}\left(\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)}-1-\frac{\mu\lambda}{1+\mu}\right)}\right)^{\beta}, \\
w^{AI} &= (1-\beta)^{1-\beta}\beta^{\beta}\tilde{\Theta}^{-\beta}\left(\frac{\bar{L}}{\bar{K}\left(\frac{1}{\alpha(1-\beta)}-1-\frac{\mu\lambda}{1+\mu}\right)}\right)^{-(1-\beta)},
\end{aligned}
$$

and

$$
P_A^{AI} = \left(\frac{\bar{K}}{\bar{L}}\left(\frac{1}{\alpha(1-\beta)}-1-\frac{\mu\lambda}{1+\mu}\right)\right)^{1-\beta}.
$$

• **Proof of Proposition ??:** Because $\tilde{V}(p)$ is minimum at $p = p^{FI}$, the autarkic price in the economy without agency costs, 1) is trivially satisfied as, for any international price $\hat{p}$, $\tilde{V}(\hat{p}) > \tilde{V}(p^{FI}) = V^{FI}$, the utility level in autarky for the full information benchmark economy.

Again because $\tilde{V}(p)$ is U shaped with a minimum at $p = p^{FI}$ and that $\lim_{p\to 0}\tilde{V}(p) = \infty$, there exists a unique threshold value $p^* < p^{FI}$ such that $\tilde{V}(p^*) = \tilde{V}(p^{AI}) = V^{AI}$, the utility level in autarky for the economy with agency costs.

- When $\hat{p} \leq p^*$, then $\tilde{V}\hat{p}) \geq \tilde{V}(p^*) = V^{AI}$ and free trade is welfare improving on autarky.

- When $p^* < \hat{p} < p^{AI}$, then $\tilde{V}(\hat{p}) < \tilde{V}(p^*) = V^{AI}$ for the case where $\hat{p} < p^{FI}$ and $\tilde{V}(\hat{p}) < \tilde{V}(p^{AI}) = V^{AI}$ for the case where $p^{FI} < \hat{p} < p^{AI}$. In both cases free trade is welfare worsening on autarky.

- Finally when $p^{AI} \leq \hat{p}$, $V^{AI} = \tilde{V}(p^{AI}) \leq \tilde{V}(\hat{p})$ and free trade is welfare improving on autarky.

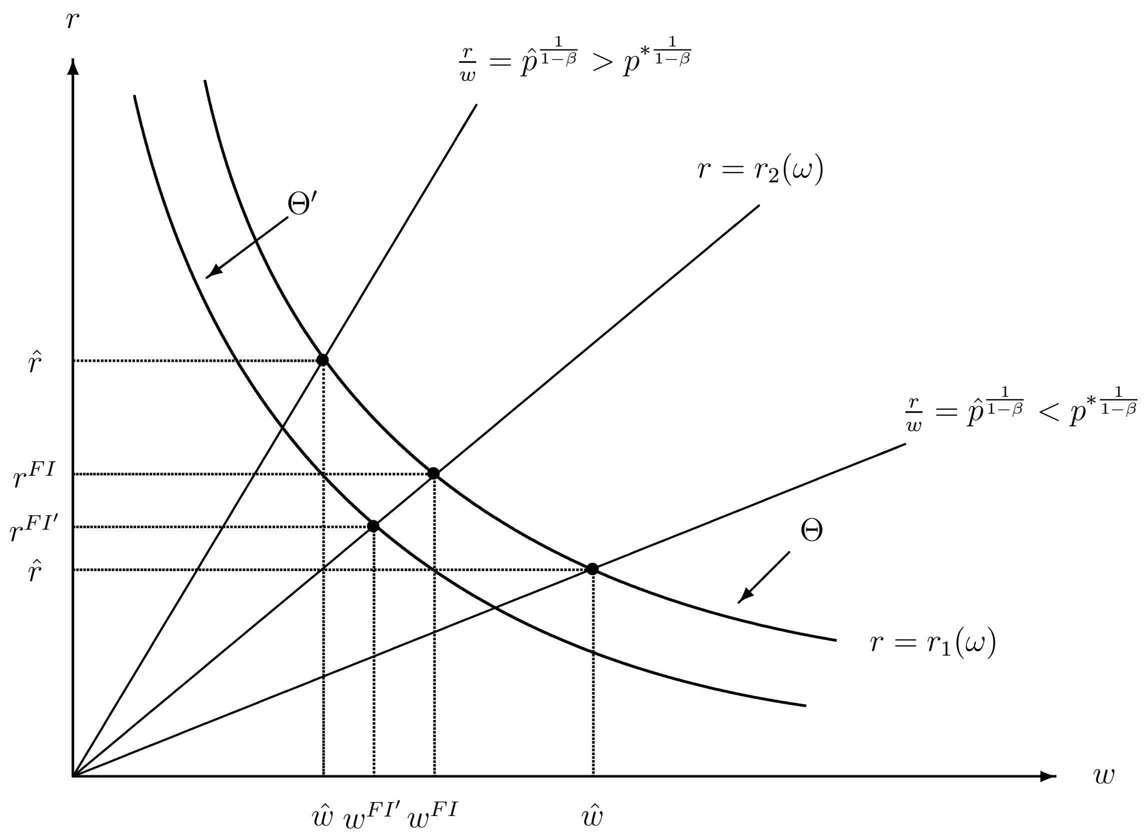

Figure 1: Autarkic equilibrium under complete information.

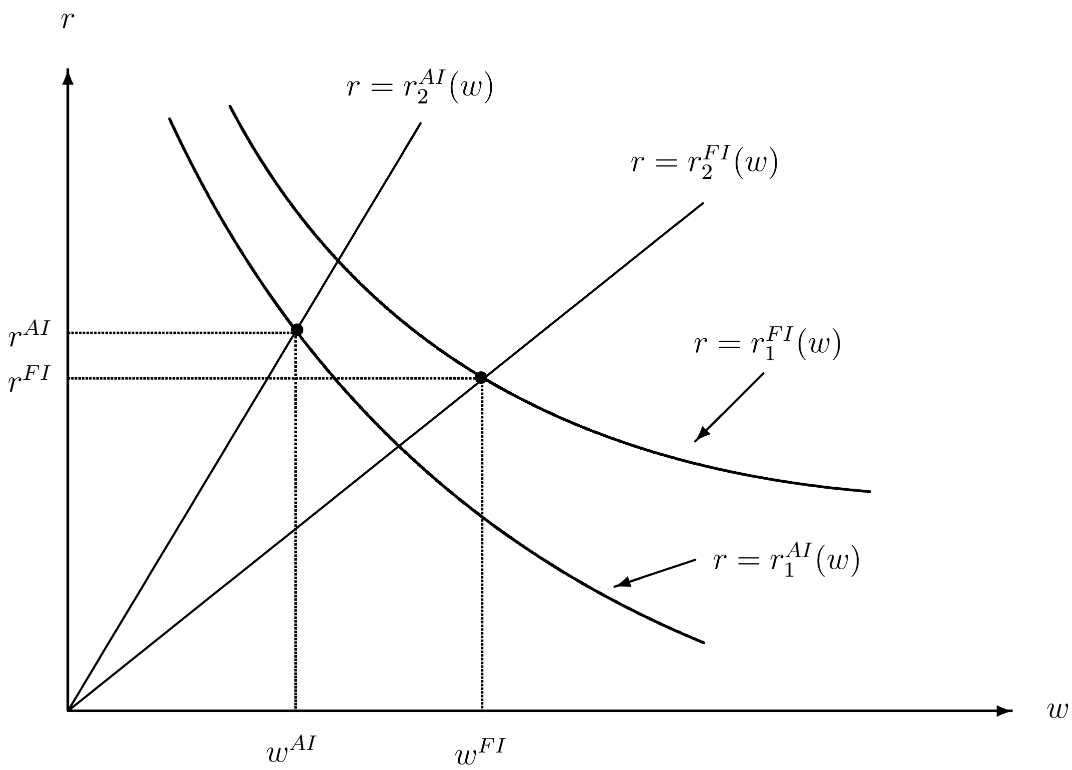

Figure 2: Comparing autarkic equilibria with and without asymmetric information. information.

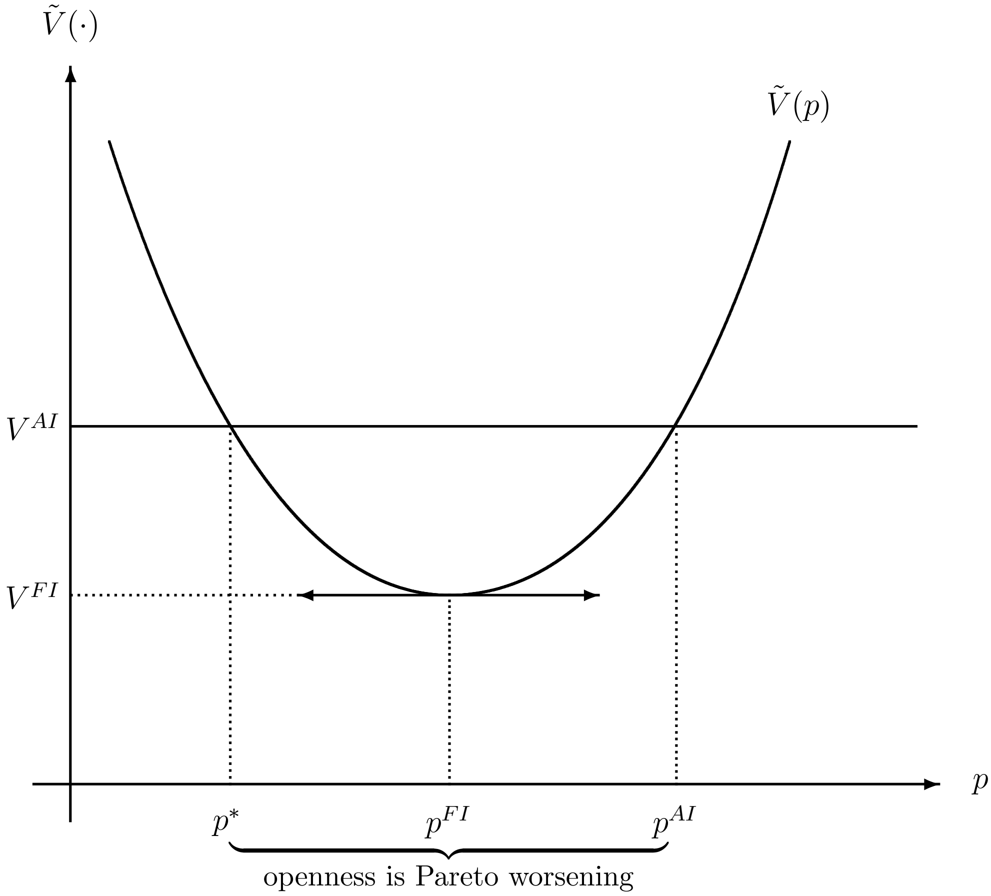

Figure 3: The Impact of Openness.