An Analysis of Optimal Size for a Special Economic Zone

SUGATA MARJIT* and HAMID BELADI**

I. INTRODUCTION

Special economic zones (SEZ) have featured in quite a few developing countries as a part of current developmental experiments. Such an institutional arrangement involves opening up of certain geographic regions of a country to foreign investment and technology. Successful SEZs have played an important role in the development of the Chinese economy. In the literature on trade and development such areas have also been coined as "export-processing" zones or "duty-free" zones. Theoretical literature in this area has been supplemented with country studies by WARR (1983, 1984, 1985). However, reasonably adequate theoretical contributions in this field have failed to address the issue of the "optimum" size of such special economic regions. The purpose of this paper is to construct a competitive general equilibrium model with a SEZ where the size of such a zone is endogenously determined. If one looks at the formation of SEZs, they essentially use foreign capital and local labor. In the Chinese case wage in such sectors is fairly high relative to the wages in the rest of the economy, CASTRO (1982) and WARR (1985) also report a similar case for Philippines. Typically a theoretical framework must be able to tackle (a) the issue of migration from the non-SEZ sector into the special area (b) wage and skill formation in the SEZ, and (c) role of the local government in determining the size of the SEZ. This paper tries to formalize these issues in terms of a tractable analytical model. Interestingly we argue that the local government may have a reason to control the inflow of local labor into the SEZ. A competitive solution would tend to put too many laborers into such a zone relative to the socially optimal inflow. In that situation it might be optimal for the local government to keep an equilibrium wage-differential between the two sectors. For expositional simplicity we shall use the term "hinterland" for the "non-SEZ" sector and "enclave" for the SEZ. Casual empiricism suggests that wage-differentials between those regions do persist in

* Indian Statistical Institute, India
** University of Dayton, USA

We would like to thank the editor and an anonymous referee for very useful comments. We would also like to thank RONALD JONES and RICHARD SNAPE for useful discussion. The usual disclaimer applies. Revised (1996).

some of the economies and «tax» rates are higher in enclaves\(^4\).

The paper is divided into four sections. In the second we discuss the basic model and the results. The third one discusses a useful extension. The last section concludes the paper with some suggestions for further research in this area.

II. THE MODEL AND ANALYSIS

Our economy consists of two sectors producing \(X_h\) and \(X_e\). \(X_h\) refers to the hinterland product and \(X_e\) to the enclave output. The local economy has only labor as the primary factor of production with a perfectly inelastic supply denoted by \(L\). \(X_h\) uses one unit of labor per unit of output. \(X_e\) can be produced only with foreign capital, perfectly elastic in supply at a given world rate of return \(r\), and «skilled» labor. Local labor has to be trained to put to work along with the foreign capital. If \(w_e\) is the wage rate at which laborers can be hired for the enclave, a per unit «training-cost» has to be added on top of it to calculate the actual per unit labor cost in the enclave. WARR (1984, 1985) has examined the performances of special economic zones where different SEZs in Asia and elsewhere combine foreign skills and technology with local trained labor to produce commodities for the world market. This suggests that firms in the special economic zones must train local unskilled labor to produce commodities for which specialized expertise are required. Hence such training costs are important. In this paper the average training cost is assumed to be an increasing function of the number of laborers involved in the enclave. We denote such a cost by,

\[
\alpha = \alpha(L_e), \; \alpha(0) = 0, \; \alpha' > 0, \; \alpha'' > 0
\]  

where \(L_e\) is the employment in the enclave. The local economy is «small» in the sense that it faces exogenously given world prices of the final goods. We also assume a neo-classical production structure for the enclave with constant returns to scale and diminishing returns.

The competitive pricing in the enclave implies that,

\[
\left[ (w_e + \alpha(L_e))a_{Le} + r a_{Ke} \right] = \bar{P}_e
\]

\(a_{Le}\) and \(a_{Ke}\) are the factor proportions and \(P_e\) is the price of the good produced in the enclave. It is straightforward to show that,

\(^4\) See Fortune International (October 5, 1992).
\[ w'_e = w_e + \alpha(L_e) = f(\overline{P}_e, \overline{r'}) + \] (3)

Equation (3) implies that with a given $\overline{P}_e$, after $\overline{r'}$ is paid out to capital, $w'_e$ is the maximum that can be spent as per unit labor cost. If $\alpha(L_e)$ is subtracted from that, $w_e$ is determined as the residual to be paid out as the wage. Competitive pricing in the hinterland suggests the following,

\[ w_h = \overline{P}_h \] (4)

Full-employment of labor implies,

\[ X_h + a_{Le} X_e = \overline{L} \] (5)

and the migration equilibrium would be given by,

\[ \left[ f(\overline{P}_e, \overline{r'}) - \alpha(L_e) \right] = w_h \] (6)

The general equilibrium of the system is determined as follows. From equation (4) $w_h$ is determined whereas equation (6) determines $L_e$. With given $L_e$, we can determine, $X_e$ since $a_{Le}$ is determined by ($w'_e / r$). Then from equation (5) we can determine $X_h$. There are essentially five unknowns, $w'_e, w_h, L_e, X_h$ and $X_e$ to be solved from five equations (2), (3), (4), (5) and (6). Figure 1, determines $L_e$ using equation (6). The left hand side of equation (6) is a declining function of $L_e$. Intersection of $AB$ and $w_h$ line (It is obvious that for the existence of an enclave $w'_e > w_h$ for $L_e = 0$) determine $L_e$ [OC] and $X_h$ [O'C]. The real national income for this economy is given by,

\[ Y = w_h(\overline{L} - L_e) + w_e L_e \] (7)

From equation (3) and (6) we have $w_e = w_h$, which implies,

\[ Y_e = \left[ w_h \cdot \overline{L} \right] \] (8)

Where $Y_e$ is the real national income as generated by the competitive solution of the system without any government intervention.

Now, we look at the problem from a planner's point of view. Suppose the local government wants to choose a level of $L_e$ that maximizes $Y$. Equation (7) can be rewritten as,
\[ Y = w_h(L - L_e) + \left[ f(P, r^*) - \alpha(L_e) \right] L_e \]  

(9)

and,

\[ \left( \frac{dY}{dL_e} \right) = \left[ f(\cdot) - \alpha'(L_e) - w_h \right] - \alpha'(L_e) \cdot L_e = 0 \]  

(10)

where,

\[ \left[ \frac{d^2Y}{dL_e^2} \right] = \left[ -2\alpha'(L_e) - \alpha''(L_e) \right] < 0 \]

Now from equation (10), we obtain,

\[ w_e = w_h + \alpha'(L_e^*) \cdot L_e^* \]  

(11)

If we compare (6) with (11), it becomes quite clear that for the national income to be maximum, \( w_e \) has to be greater than \( w_h \). The optimum gap is determined by \( [\alpha'(L_e^*) \cdot L_e^*] \). Equations (6) and (11) also imply that \( L_e > L_e^* \). The optimal level of \( L_e^* \) is determined by the intersection of \( AB' \) with \( w_h \) where \( AB' \) denotes \( [w_e - \alpha (L_e) - \alpha'(L_e) \cdot L_e] \) and \( OC' = L_e^* < L_e = OC \). And, the wage-gap is denoted by \( EF \). Therefore, we can write down the following proposition.

**Proposition I:** Socially optimal size of the enclave is smaller than the one attainable under competition. Moreover, there has to be a "wage-gap" between the enclave and the hinterland.

The intuitive explanation of the above result is quite straightforward. Marginal loss of pulling one unit of labor out of the hinterland is \( w_h \). Marginal gain of reallocating this labor into the enclave is given by \( [w_e - \alpha (L_e) - \alpha'(L_e) \cdot L_e] \). Therefore, \( L_e^* \) would be determined by,

\[ w_h = [w_e - \alpha (L_e) - \alpha'(L_e) \cdot L_e] \]  

(12)

For \( L_e \) number of people employed in the enclave, total cost of training is \( [\alpha (L_e) \cdot L_e] \) and for a unit increment in the enclave labor force, total cost increases by \( [\alpha (L_e) + \alpha'(L_e) \cdot L_e] \). Hence, \( [w_e - w_h] \) must compensate for that. However, as far as the individual migrant is concerned, the only consideration is \( [w_e - \alpha (L_e)] \). Hence, there is too much influx of migrants into the enclave.
The question now is how to implement \( L^* \). Since, \( w_e > w_h \) for \( L_e = L^* \), there would be continuing outflow from the hinterland. Therefore, the government must impose a wage-tax in the enclave to prevent this. Let \( t \) be such a tax, then,

\[
w_e (1 - t) = w_h
\]

Now for the optimum,

\[
w_e = \left[ w_h + \alpha' (L^*_e) \cdot L_e \right]
\]

By, combining equations (13) and (14) we get,

\[
t^* = \left[ \frac{\alpha' (L^*_e) \cdot L_e}{w_h + \alpha' (L^*_e) \cdot L_e} \right]
\]

As the figure shows, \( t^* \), would be such that \( \left[ w_h / 1 - t^* \right] \) must intersect \( AB \) at \( E \). This would determine \( EF \) as the equilibrium wage differential \(^5\).

**Proposition 2:** \( \exists \) a wage-tax for the enclave implementing the optimum inflow, \( L^*_e \).

A rise in the hinterland wage rate will reduce \( t^* \) by reducing the gap between the market determined inflow and the optimum level. This can be shown by observing that,

\[
t^* = \frac{1}{1 + \frac{w_h}{\alpha' (L^*_e) \cdot L_e}}
\]

A rise in \( w_h \) also reduces \( L^*_e \). Therefore, \( \left[ \alpha' (L^*_e) \cdot L_e \right] \) goes down and is increasing the denominator in equation (16). One way of interpreting \( \alpha (L_e) \) is to consider a situation where foreign personnel are hired to train the locals.

Let \( \bar{w}^* \) be the given wage rate in the rest of the world for specialists who can train the locals and the training requires, \( b \) number of trainers per trainee for \( L_e \) number of trainees. Moreover, \( b \) is related to \( L_e \) by the following,

\[
b = b(L_e), b' > 0, b'' > 0
\]

---

5. The restricted mobility is somewhat achieved in China by issuing registration cards for the citizens for a particular province legally restricting their movement. Here we talk about a fiscal measure.

6. \( b(L_e) \) can also be interpreted as the number of trainers measured in terms of the efficiency units. The same trainer might have to reduce the average time spent on the unskilled worker if number of such workers increases. Therefore, to maintain the same level of productivity as before an average trainer might need to work harder and hence be paid more. Even if \( b'(L_e) < 0 \) initially due to some sort of
Then,

$$\alpha (L_e) = \overline{w^*} b(L_e)$$  \hspace{1cm} (18)

Now instead of the government if an agency or a cartel of the foreign firms would control the inflow of local labor into the enclave, $L_e$ would have been chosen to maximize (19).

$$\bigg[(w'_e - w_h) - \overline{w^*} b(L_e)\bigg] L_e$$  \hspace{1cm} (19)

The result would have been $L_e^*$ by solving (11). The surplus generated out of such a scheme would have accrued to the agency or the cartel. Since the enclave is otherwise characterized by competition, the government can use its sovereign power to introduce a tax and implement $L_e^*$ to achieve the social optimum. Also note that «taxes» do not appear in the national income calculations because they are just transfers from the workforce to the government.

One way to characterize, $t^*$, is to relate it to the elasticity of the $w_e$ function. From equation (13) and (14) one can write,

$$t^* = -\frac{\partial \big[w'_e - \alpha (L_e^*)\big]}{\partial L_e^*} \frac{L_e^*}{w'_e - \alpha (L_e^*)}$$  \hspace{1cm} (20)

where $\eta_e$ is the proportionate change in $w_e$ with respect to a change in $L_e$. Now, by rewriting equation (20) we obtain,

$$t^* = \eta_e$$

$$= \frac{\alpha'(L_e^*)}{\alpha(L_e^*)} \frac{\alpha(L_e^*)}{w'_e - \alpha(L_e^*)}$$

$$= \beta_e \frac{\alpha(L_e^*)}{w_e}$$  \hspace{1cm} (21)

when $\beta_e$ is the elasticity of the training cost function.

The simplified general equilibrium structure of the model could be made more complex by introducing a sector specific factor in the hinterland. With constant returns economies of scale, we believe, as $L_e$ increases beyond a point, the diminishing returns will set in. In fact, $b'(L_e) < 0$ does not hurt our results so long as $w_h$ intersects $AB$ in its decreasing stretch i.e. when $b'(L_e) > 0$. This is demonstrated in the last section.
to scale and diminishing returns $w_h$ would be a declining function of $\bar{L} - L_e$. As figure 2 illustrates, the required $L_e$ would be higher in that case. As $w_h$ declines with $(L - L_e)$, the optimum wage differential could be attained with a higher $L_e$ than in the previous case with respect to a common competitive solution. In the process the return to sector-specific factor used in the hinterland would also increase relative to the benchmark equilibrium\(^7\). (See the appendix.) It is interesting to note that even in the absence of any training costs the same wage-tax structure would prove to be an optimal policy for the enclave in a specific factor structure, where labor is mobile factor with a specific factor (foreign capital) in the SEZ as long as income from specific capital is repatriated to the source country. So that in a model with a sector specific foreign owned factor whose income is to be repatriated, such a wage-tax scheme would be an optimal policy. The main point is that without such a wage-tax, there might be an over-inflow of unskilled labor into the enclave.

III. FIXED COST OF TRAINING

It seems that the training cost in the enclave should realistically contain a fixed part. Let us assume that such a fixed cost is denoted by $F$. This alters the average cost-price equality relationship (2) which looks like the following\(^8\),

$$\frac{F}{X_e(L_e)} + \left[ w_e + \alpha(L_e) \right] \alpha_{L_e} + r a_{K_e} = P_e$$

(22)

Also note that the condition for migration equilibrium would be given by

$$w_h = w_e \frac{P - r a_{K_e}}{a_{L_e}} \frac{F}{L_e} - \alpha(L_e)$$

(23)

Right hand side of (23) is captured in Figure 3. With $L_e$ increasing there is a declining average fixed cost and an increasing average variable cost. It is reasonable to presume that the increase in $\alpha(L_e)$ would eventually over-compensate a declining $F / L_e$ leading to two possible equilibria such as $e_1$, $e_2$ in Figure 3. Consider the labor located at $e_1$. It is obvious that if he goes to the enclave, he gets more. Hence, $e_1$ would be an unstable equilibrium. One can not have a situation where $OM_1$ would be allocated to the enclave and $M_1'0'$ to the hinterland. In this case $e_2$ is the meaningful equilibrium. Where no further incentive exists for the laborers to go to the enclave. If we focus on $e_2$, then our

\(^7\) For more details, see JONES (1971).

\(^8\) It should be noted that $F$ can be fixed wage payments, to the foreign personnel training the locals. Therefore, $F$, can be exogenous and not determined from within the system.
analysis would be quite similar to that in the earlier section. As long as we operate in the downward stretch of the $w_e$ function, a tax scheme is needed to eliminate the external problem. Of course the conclusion would be very different if we drop the assumption the increasing cost of training labor in the enclave.

As was mentioned earlier, the specific factor model would yield the same optimal tax even when training costs are absent. In the present model, our result depends on the importance and nature of training costs in the foreign enclave in a less developed country. The scenario which we have developed in this paper exhibits a situation where product of exports is made possible by combining the unskilled labor force with skilled factors and managerial and «technical-know-how» from the world market. Since in our model foreign capital income is not repatriated, unskilled laborers continue to move into the special economic zone until the wage at which laborers can be hired for the enclave equals the wage rate in the hinterland ($w_e = w_h$) but competitive equilibrium will not accommodate for the increasing training costs, hence a required socially optimal wage gap between the hinterland wages and that of the enclave and this can be obtained by devising a wage-tax policy for the special economic zone.

IV. CONCLUDING REMARKS

This paper has been an attempt to provide an analytical framework to determine the optimum size of an enclave where local labor is used along with foreign capital. Introducing an increasing training cost to prepare the local labor for the enclave, we can determine the equilibrium allocation of labor. Competitive solution could be improved by the government by creating an optimum wage differential and controlling labor flows into the enclave. The basic result carries through in a model with a more complicated production structure in the hinterland and with fixed cost of training. The role of government intervention appears only because there is no private agency which can control labor supply into the enclave and internalize the increasing marginal cost of training. Also the assumption that the enclave is «competitive» plays an important part. It should be noted that the results of our model and the recommendation of a special tax to limit the inflow of labor force into the special economic zone strongly depends on the assumptions concerning the training costs.

One could extend the model in several directions. For example one could introduce unemployment and talk about employment effects which might affect the optimum size of an enclave. The special economic zones are usually geared to exports and foreign exchange earning might be another consideration for the government. The net foreign exchange earned would depend on remittances to the foreign countries. A part of it might accrue to the foreign nationals who train the locals. Explicit consideration regarding foreign exchange obligations might hurt training activities of the locals. A dynamic extension of the model might be where one can talk about the «social externality» of trained labor. Process of such «human capital» formation could possibly be related
the modern theories of growth. Lastly one could argue that the ability to «hire and fire» in the enclave might inject some bias in favor of staying back with a «secured» job in the hinterland. If one follows the Chinese case, entrepreneurs in the enclave are relatively free in taking the employment decisions. Such microeconomic issues can be interwoven with the simple general equilibrium structure discussed in the paper.

APPENDIX

In case the hinterland has a specific-factor, say, the domestic capital, the expression for national income changes to

\[
Y = \left[w'_e - \alpha(L_e)\right]L_e + Y_h(L_h, \overline{K}_h)
\]

(1A)

where \(\overline{K}_h\) is the given supply of domestic capital. Now \(L^*_e\) is determined from,

\[
\left[w_e - \frac{\partial Y_h}{\partial L_h}\right] = \alpha'(L^*_e) \cdot L^*_e
\]

(2A)

where,

\[
\left(\frac{\partial Y_h}{\partial Y_h}\right) = w_h
\]
If we start from a common reference point such as E, a fixed $W_h$ yields a lower optimum level of $L_e$ relative to the specific-factor case denoted by $F$ and $F'$. 
REFERENCES


**SUMMARY**

We use a general equilibrium framework with training costs to characterize a special economic zone which uses foreign capital and local labor. Competitive equilibrium without government intervention leads to «overflow» of local labor in the foreign enclave. A sector-specific wage tax implements the «first-best» level of employment in the special economic zone, justifying active government intervention. Our result holds in the extended version of the basic model.

**ZUSAMMENFASSUNG**

In diesem Beitrag wird eine spezielle Wirtschaftszone, in welcher ausländisches Kapital und einheimische Arbeitskräfte eingesetzt werden, im Rahmen eines allgemeinen Gleichgewichtsmodells mit Ausbildungskosten untersucht. Das kompetitive Gleichgewicht ohne staatliche Eingriffe führt zu einem übermässigen Zufluss von Arbeitskräften in die Zone. Durch eine sektorspezifische Lohnsteuer kann das optimale Beschäftigungsniveau in der speziellen Wirtschaftszone erreicht werden, was einen staatlichen Eingriff sinnvoll erscheinen lässt. Dieses Resultat bleibt auch in einem erweiterten Modell gültig.

**RESUME**

Cet article examine une zone économique spéciale utilisant du capital étranger et une force de travail nationale dans le cadre d’un modèle d’équilibre général incluant des coûts de formation. L’équilibre compétitif sans intervention gouvernementale mène à une immigration suroptimale de travailleurs dans la zone. Le niveau optimal de l’emploi peut être atteint par l’introduction d’un impôt spécifique sur les salaires, ce qui justifie une intervention estatale. Ce résultat reste valable dans un modèle élargi.