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Article

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European Journal of Economics and Economic Policies: Intervention (EJEEP)

Provided in Cooperation with:

Edward Elgar Publishing

Suggested Citation: Trigg, Andrew B.; Araujo, Ricardo Azevedo (2018) : A multi-sectoral approach to the Harrod foreign trade multiplier, European Journal of Economics and Economic Policies: Intervention (EJEEP), ISSN 2052-7772, Edward Elgar Publishing, Cheltenham, Vol. 15, Iss. 1, pp. 91-104,
<https://doi.org/10.4337/ejeep.2017.0024>

This Version is available at:

<https://hdl.handle.net/10419/277407>

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A multi-sectoral approach to the Harrod foreign trade multiplier

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With this inquiry, we seek to develop a multi-sectoral version of the static Harrod foreign trade multiplier, by showing that it can be derived from an extended version of the Pasinettian model of structural change and international trade. This new version highlights the connections between the balance of payments and levels of employment and production. It is also shown that from this disaggregated version of the Harrod foreign trade multiplier we can derive an aggregate version of the multiplier. By following this approach we go a step further in establishing the connections between the structural economic dynamic and the balance-of-payments-constrained-growth approaches.

Keywords: *structural economic dynamics, foreign trade multiplier, balance-of-payments-constrained growth*

JEL codes: *O19, F12*

1 INTRODUCTION

‘The causes which determine the economic progress of nations belong to the study of international trade ...’ Alfred Marshall, *Principles of Economics*, Book Four (1890)

This paper deals with the relationship between income determination and balance-of-payments equilibrium in a structural economic dynamic – SED hereafter – setting. In particular, the paper delivers a multi-sectoral version of the static Harrod foreign trade multiplier (Harrod 1933) by showing that it can be derived from an extended version of the Pasinettian model (Pasinetti 1993) that takes into account foreign trade (Araujo/Teixeira 2004). Besides, in order to prove the consistency of our approach, we also show that by departing from the multi-sectoral Harrod foreign trade multiplier we can obtain the aggregate version, with an emphasis on the role played by economic structures in determining output performance. The disaggregated version of the multiplier is then shown to keep the original flavour of the aggregate version since it predicts that the output

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** Email: rsaaraujo@unb.br. Ricardo Araujo wishes to express thanks for financial support from the Brazilian Council of Science (CNPq). A preliminary version of this paper was presented to the 19th FMM Conference of the Research Network Macroeconomics in Berlin, 2015. We would like to thank, without implication for any remaining errors, two anonymous referees for helpful comments.

Received 27 January 2015, accepted 13 October 2016

of each sector is strongly affected by its export ability, which highlights that the validity of Harrod's original insight is not restricted to the aggregate level.

The SED framework is adopted as the starting point for our analysis. Initially, this model was conceived for studying the interactions between growth and structural change in a closed economy¹ (see Pasinetti 1981; 1993). However, more recently it was formally extended to take into account international flows of goods (see Araujo/Teixeira 2004), and a balance-of-payments-constrained growth rate was derived in this set-up under the rubric of the multi-sectoral version of Thirlwall's law (see Araujo/Lima 2007). Such extensions have proven that the insights provided by Pasinettian analysis remain valid for the case of an open economy: the interaction between tastes and technical change is responsible for variations in the structure of the economy, which in turn affect the overall growth performance.

This view is also implicit in the balance-of-payments-constrained-growth – BPCG hereafter – approach, to the extent that variations in the composition of exports and imports lead to changes in the structure of the economy and determine the output growth consistent with balance-of-payments equilibrium (see Thirlwall 2013). By assuming that the real exchange rate is constant and that trade must be balanced in the long run, the BPCG approach asserts that there is a very close correspondence between the growth rate of output and the ratio of the growth of exports to the income elasticity of demand for imports. Indeed, this result is the prediction of a dynamic version of the Harrod (1933) trade multiplier known as Thirlwall's law (see Thirlwall 1979).

It can also be argued that the particular dynamics due to the interaction of technical change and patterns of demand are taken into account in the BPCG approach, since observed differences in the income elasticities of demand for exports and imports reflect the non-price characteristics of goods and, therefore, the structure of production (Thirlwall 1997: 383). But in fact, by using the aggregate Keynesian model as its starting point, the literature on both the static and dynamic Harrod foreign trade multiplier is advanced in terms of an aggregate economy, in which it is not possible to fully consider particular patterns of demand and productivity for different goods.

Harrod (1933) considered an open economy with neither saving and investment nor government spending and taxation. In this set-up, income, Y , is generated by the production of consumption goods, C , and exports, X , namely: $Y = C + X$. It is assumed that all income is spent on consumption goods and imports (M), such that $Y = C + M$. The real terms of trade are constant and balanced trade is assumed: $X = M$. If we assume a linear import function such as $M = mY$, where m is the marginal propensity to import, after some algebraic manipulation this yields:

$$Y = \frac{1}{m}X. \quad (1)$$

Expression (1) is known as the static Harrod foreign trade multiplier,² under which the main constraint on income determination is the level of export demand in relation to the

1. The Pasinettian model presents both a static and dynamic multi-sectoral analysis, a characteristic that contrasts with other multi-sectoral models such as input–output analysis, which is predominantly static in approach.

2. The dynamic Harrod foreign trade multiplier is connected to the Hicks supermultiplier. While the former considers just the impact of the growth rate of exports on the growth rate of output, the latter also takes into account the feedbacks that a higher growth rate of exports has on other components of autonomous expenditure. According to McCombie (1985: 63), 'an increase in exports will allow other autonomous expenditures to be increased until income has risen by enough to induce an increase in imports equivalent to the initial increase in exports'.

propensity to import. McCombie/Thirlwall (1994: 237) claim that ‘Harrod put forward the idea that the pace and rhythm of industrial growth in open economies were to be explained by the principle of the foreign trade multiplier which at the same time provided a mechanism for keeping the balance-of-payments in equilibrium’. Any change in X brings the balance of trade back into equilibrium through changes in income and not in relative prices. According to that view, the Harrod foreign trade multiplier is an alternative to the Keynesian determination of income through the investment multiplier.

The subsequent development of Harrod’s analysis has been to study the growth implications of his model; but, as pointed out by Thirlwall (2013: 83), Harrod himself never managed to accomplish such a task. This has been carried out by a number of authors who built on the insights of Kaldor (1966) as a starting point (see for example Thirlwall 1979; McCombie 1985; Setterfield 2010). Probably the main outcome of this strand has been developed in terms of a dynamic version of the Harrod foreign trade multiplier that became known in the literature as Thirlwall’s law (McCombie/Thirlwall 2004). According to this view, the Harrod multiplier was turned into a theory of BPCG, in which the growth process is demand-led rather than supply-constrained. Assuming constant real exchange rates and that trade must balance in the long run, there is a very close correspondence between the growth rate of output and the ratio of the growth of exports to the income elasticity of demand for imports, namely π :

$$\frac{\Delta Y}{Y} = \frac{1}{\pi} \frac{\Delta X}{X}. \quad (2)$$

According to this expression, which derives from (1), the growth rate of output, $\frac{\Delta Y}{Y}$, is related to the growth rate of exports, $\frac{\Delta X}{X}$, by the inverse of the propensity to import, represented by m . Thus in a balanced trade framework with the real terms of trade constant, countries are constrained to grow at this rate, which in its continuous time version became widely known as Thirlwall’s law.³ According to this view the balance-of-payments position of a country is the main constraint on the overall growth rate, since it imposes a limit on demand to which supply can (usually) adapt. As it turns out, observed differences in growth performance between countries are associated with particular elasticities of demand for exports and imports.

In this context, structural change features as one of the sources of change in the elasticity of income for exports and imports, with such elasticities being seen as the weighted average of sectoral elasticities. In such a view, structural change due to variations in the share of exports/imports may give rise to changes in aggregate elasticities. Arguably, a country whose structure is concentrated on sectors that produce raw materials, for instance, will have a lower income elasticity of demand for exports than a country specializing in the production of sophisticated goods. From this perspective we may conclude that the policy implications of the SED and the BPCG approaches are similar: underdeveloped countries should pursue structural changes in order to produce and export goods with a higher income elasticity of demand (see Thirlwall 2013).

Previous attempts to establish connections between these two strands have proven fruitful. Results such as the multi-sectoral version of Thirlwall’s law (Araujo/Lima 2007) and the disaggregated version of the cumulative model (Araujo 2013 and Araujo/Trigg 2015) have shown that demand, captured mainly by income elasticities, can play a central role in determining growth rates even in the long run. These developments have shown

3. Note, however, that according to McCombie (1985: 71) the conciliation between Thirlwall’s law and the dynamic foreign trade multiplier is not so straightforward since the former is based on a multiplicative import function while the latter is based on a linear import function.

that disaggregated assessments of well-established results in that literature can give rise to new insights (see Pasinetti 2005).

Kaldor himself abandoned the aggregate view in search of a sectoral and regional approach that would emphasize divergence of growth rates, dynamic returns of scale, cumulative causation and path dependence in economic development (see for example Hein 2014). Taking a disaggregated approach led him to conclude that the manufacturing sector plays a key role in establishing the pace of economic growth due to its positive effects on overall labour productivity growth. Such effects are related to the existence of significant forward and backward linkages in the production chain of the manufacturing sector, whereby a productivity gain in one industry may be spread to others due to such linkages. Following such developments, the so-called 'Kaldor growth laws' (Kaldor 1966 and Thirlwall 1987) convey a strong sectoral flavour in so far as the manufacturing sector is seen as the 'engine of growth'. In such a view the process of economic development is conceived not only as economic growth but also as a type of structural change in which the transfer of labour from low to high productivity sectors plays an important role in determining overall productivity.

However, despite the importance given by Kaldor to a disaggregated analysis, the formal model employed to support his verbal reasoning (see Dixon/Thirlwall 1975 and Thirlwall 1997) is built in terms of an aggregate economy. And the main component of this model is a dynamic version of the Harrod foreign trade multiplier, as derived in Araujo/Trigg (2015). This provides a basis for the analysis here, following the Kaldorian view that output and output growth are determined by external constraints, considering the driving force of growth as demand rather than supply, thereby disregarding other constraints such as saving and capital capacity.⁴

In order to carry out the present analysis we have adopted a procedure analogous to the one advanced by Trigg/Lee (2005) and extended by Araujo/Trigg (2015) to consider international trade. The former work explores the relationship between the Keynesian multiplier and Pasinetti's model of pure production in a closed economy, by showing that it is indeed possible to derive a simple multiplier relationship from multi-sectoral foundations in a closed version of the Pasinetti model; hence a scalar multiplier can legitimately be applied to a multi-sector economy. By departing from this result, Araujo/Trigg (*ibid.*) have derived an initial formulation of the multi-sectoral disaggregated Harrod foreign trade multiplier. Here we go a step further by showing through aggregation the consistency of such a formulation with the original Harrod foreign trade multiplier. A direct mathematical translation is provided between these multi-sectoral and aggregate Harrod systems. Such a formulation requires the introduction of the price system: a task not performed by Araujo/Trigg (*ibid.*). Following this approach, we show, for instance, that the equilibrium Pasinettian solution for the system of physical quantities may be obtained as a particular case of the solution given by the multi-sectoral Harrod foreign trade multiplier, derived here when the condition of trade balance is satisfied. With this analysis, we intend

4. Thirlwall (2012: 22) acknowledges that 'growth may be constrained either by domestic saving or by foreign exchange, and that the role of foreign borrowing in the development process is to relieve whichever is the dominant constraint. Chenery's view, like that of Prebisch, was that for most developing countries, at least in the intermediate stage of economic development, the dominant constraint is likely to be a shortage of foreign exchange associated with balance of payments deficits, so that growth would be balance-of-payments constrained'. But even by recognizing that there may be other constraints to the growth process, the message of the BPCG model remains; namely, it is not possible for a country to grow consistently at a rate much different from that which allows equilibrium in the balance of payments.

to emphasize the view that in the presence of a favourable economic structure a country's aggregate output level may be improved by relaxing the balance-of-payments constraint.

The paper is structured as follows. In Section 2, we present an extended version of the multi-sectoral Pasinettian model of international trade, followed in Section 3 by a consideration of the multi-sectoral Harrod multiplier. Section 4 shows how the original scalar Harrod multiplier can be derived from these multi-sectoral foundations, exploring how this relates to the Harrod matrix multiplier. In Section 5 some conclusions are provided.

2 SYSTEMS OF PHYSICAL AND MONETARY QUANTITIES IN AN EXTENDED VERSION OF THE PASINETTIAN MODEL TO INTERNATIONAL TRADE

The SED and the BPCG approaches embody a shared view that demand plays an important role in the growth process, but with different degrees of emphasis. While the SED framework focuses on structural changes accruing from the existence of particular growth rates of demand and technical change for each sector, the BPCG literature considers that elasticities of demand for exports and imports are responsible for explaining particular growth experiences (see Thirlwall 2012).

A common feature of both approaches is that the notion of equilibrium plays a central role. While in the BPCG approach equilibrium in the balance-of-payments is a required condition of sustainability in the long run, the SED approach shows that the most probable macroeconomic consequence of the growth process is disequilibria, which translate into structural unemployment. But it is undeniable that even in the SED approach equilibrium in the balance of payments should be observed in the long run. The direct consequence of this characteristic is that the evolving patterns of technical change and preferences cannot be exogenous but will be subject to an external constraint, as highlighted in the BPCG approach. An important feature of the SED approach is that it can establish normative conditions for full employment of the labour force and conditions for equilibrium in the balance of payments, although it is straightforward to prove that the former will not generally be satisfied.

To formally consider these insights, a starting point is the extended version of the pure labour Pasinettian model of foreign trade as advanced by Araujo/Teixeira (2004). Demand and productivity vary over time at a particular rate in each sector of two countries; the advanced country is denoted by A and the underdeveloped country by U . Assume also that both countries produce $n - 1$ consumption goods, but with different patterns of production and consumption. In order to establish the basic notation, it is useful to choose one of the countries, let us say U , to express physical and monetary flows. The system of physical quantities may be expressed as:

$$\begin{bmatrix} \mathbf{I} & -(\mathbf{c} + \xi \mathbf{c}^e) \\ -\mathbf{a} & 1 \end{bmatrix} \begin{bmatrix} \mathbf{X} \\ X_n \end{bmatrix} = \begin{bmatrix} \mathbf{0} \\ 0 \end{bmatrix}, \quad (3)$$

where \mathbf{I} is an $(n - 1) \times (n - 1)$ identity matrix, $\mathbf{0}$ is an $(n - 1)$ null vector, $\mathbf{X} = \begin{bmatrix} X_1 \\ \vdots \\ X_{n-1} \end{bmatrix}$ is the $(n - 1)$ column vector of physical quantities, $\mathbf{c} = \begin{bmatrix} a_{1n} \\ \vdots \\ a_{n-1,n} \end{bmatrix}$ is the $(n - 1)$ column

vector of consumption coefficients, $\mathbf{c}^e = \begin{bmatrix} a_{1n}^e \\ \vdots \\ a_{n-1,n}^e \end{bmatrix}$ refers to the $(n-1)$ column vector of

foreign demand coefficients, and $\mathbf{a} = [a_{n1} \cdots a_{n,n-1}]$ is the $(n-1)$ row vector of labour coefficients. X_n denotes the quantity of labour in all internal production activities. The household sector in country A is denoted by \hat{n} and the population sizes in both countries are related by the coefficient of proportionality ξ . According to Pasinetti (1993), system (3) is a homogenous and linear system; hence a necessary condition to ensure non-trivial solutions of the system for physical quantities is

$$\det \begin{bmatrix} \mathbf{I} & -(\mathbf{c} + \xi \mathbf{c}^e) \\ -\mathbf{a} & 1 \end{bmatrix} = 0. \quad (4)$$

Condition (4) may be equivalently written (see Araujo/Teixeira 2004) as:

$$\mathbf{a}(\mathbf{c} + \xi \mathbf{c}^e) = 1. \quad (4')$$

If condition (4') is fulfilled then there exists a solution for the system of physical quantities in terms of an exogenous variable, namely \bar{X}_n . In this case, the solution of the system for physical quantities may be expressed as:

$$\begin{bmatrix} \mathbf{X} \\ X_n \end{bmatrix} = \begin{bmatrix} (\mathbf{c} + \xi \mathbf{c}^e) \bar{X}_n \\ \bar{X}_n \end{bmatrix}. \quad (5)$$

From the first $n-1$ lines of (5), we conclude that in equilibrium the physical quantity of each tradable commodity to be produced in country U , that is, X_i , $i = 1, \dots, n-1$, will be determined by the sum of the internal and foreign demand, namely $a_{in} \bar{X}_n$ and $\xi a_{in}^e \bar{X}_n$ respectively. The last line of (5) shows that the labour force is fully employed. It is important to emphasize that solution (5) holds only if condition (4') is fulfilled. If (4') does not hold, then the non-trivial solution of physical quantities cannot be given by expression (5).

The economy depicted by system (3) may also be represented by a system of monetary quantities, where total wages are spent on domestic consumption goods (represented by domestic coefficients, \mathbf{c}) and imports of foreign goods (represented by import coefficients, \mathbf{c}^m). The monetary system may be written as:

$$[\mathbf{p} \ w] \begin{bmatrix} \mathbf{I} & -(\mathbf{c} + \mathbf{c}^m) \\ -\mathbf{a} & 1 \end{bmatrix} = [\mathbf{0} \ 0], \quad (6)$$

where $\mathbf{p} = [p_1 \cdots p_{n-1}]$ is the $(n-1)$ row vector of money prices, $\mathbf{c}^m = \begin{bmatrix} a_{1n}^m \\ \vdots \\ a_{n-1,n}^m \end{bmatrix}$ is the

$(n-1)$ column vector of consumption import coefficients, and w is the uniform wage. Like system (3), system (6) is also a homogenous and linear system; hence a necessary condition to ensure non-trivial solutions for prices should be observed, that is:

$$\det \begin{bmatrix} \mathbf{I} & -(\mathbf{c} + \mathbf{c}^m) \\ -\mathbf{a} & 1 \end{bmatrix} = 0. \quad (7)$$

Condition (7) may be equivalently written (see Araujo/Teixeira 2004) as:

$$\mathbf{a}(\mathbf{c} + \mathbf{c}^m) = 1. \quad (7')$$

If condition (7') is fulfilled then there exists a solution for the system of monetary quantities in terms of an exogenous variable, namely \bar{w} . In this case, the solution of the system for monetary quantities may be expressed as:

$$[\mathbf{p} \ w] = [\mathbf{a}w \ \bar{w}]. \quad (8)$$

From the first $n - 1$ lines of (8), we conclude that in equilibrium the price of each tradable commodity is given by the amount of labour employed in its production, that is, $p_i = a_{in}\bar{w}$, $i = 1, \dots, n - 1$. If expressions (5) and (8) hold simultaneously, it is possible to show after some algebraic manipulation that they express a new condition, which can be viewed as embodying a notion of equilibrium in the balance of trade. If $\mathbf{a}(\mathbf{c} + \xi\mathbf{c}^e) = 1$ and $\mathbf{a}(\mathbf{c} + \mathbf{c}^m) = 1$, then by equalizing the left-hand side of both expressions we obtain:

$$\mathbf{a}(\xi\mathbf{c}^e - \mathbf{c}^m) = 0. \quad (9)$$

The fulfilment of conditions (4') and (7') implies equilibrium in the trade balance but the reverse is not true. Note for instance that if $\mathbf{a}(\mathbf{c} + \xi\mathbf{c}^e) = 0.9$ and $\mathbf{a}(\mathbf{c} + \mathbf{c}^m) = 0.9$, the trade balance condition will also be fulfilled by equalizing the right-hand side of both expressions, but this situation corresponds to unemployment and underexpenditure of national income. That is, the trade balance equilibrium implies neither full employment of the labour force nor full expenditure of national income. This possibility has been somewhat emphasized by the BPCG approach. The idea is that the full expenditure of national income in a context of balance-of-payments equilibrium means that even if such income is spent abroad as imports, such expenditure will be compensated in terms of exports, leading to equilibrium in the labour market. According to our alternative rationale, however, based on (9), a trade deficit may lead to a level of employment different from full employment equilibrium.

According to this view, the main constraint on the performance of a country is related to the balance of payments, which must be balanced in the long run. In this set-up a poor export performance may lead to low levels of employment and national output, thus showing that the external constraint may be more relevant than shortages in saving and investment, for developing countries in particular. In this context, the Harrod foreign trade multiplier plays a decisive role since it changes the focus of determination of national income from investment to exports. From the first line of expression (8), we know that $\mathbf{p} = \mathbf{a}w$. Hence by assuming a wage unit, namely $w = 1$, money prices are equal to labour coefficients, and the equilibrium in the trade balance may be rewritten as:

$$\mathbf{p}(\xi\mathbf{c}^e - \mathbf{c}^m) = 0. \quad (9')$$

In the next section, a disaggregated version of the Harrod foreign trade multiplier is derived from the system of physical quantities. The system of monetary quantities will be employed in order to arrive at the aggregate version of the static Harrod foreign trade multiplier.

3 DERIVATION OF THE MULTI-SECTORAL STATIC HARROD FOREIGN TRADE MULTIPLIER

The idea of developing a multi-sectoral version of the Keynesian multiplier dates back to derivations by Goodwin (1949) and Miyazawa (1960) of a disaggregated version of the income

multiplier in Leontief's framework, from a relatively simple Keynesian structure. Both authors emphasized that although there are important differences between the Keynes and Leontief approaches, a bridge between them – namely a disaggregated version of the multiplier – could provide a potentially important development for the literature. In order to derive a multi-sectoral version of the Harrod foreign trade multiplier, let us adopt a procedure similar to the one advanced by Trigg/Lee (2005) and extended by Araujo/Trigg (2015). Dealing with the original Pasinettian model, Trigg/Lee (2005) had to assume that investment in the current period becomes new capital inputs in the next period and that the rate of depreciation is 100 per cent (that is, all capital is circulating capital) in order to derive the Keynesian multiplier. By considering an economy extended to foreign trade, however, we do not need this hypothesis. Let us rewrite the system of physical quantities in (3) as:

$$\begin{bmatrix} \mathbf{I} & -\mathbf{c} \\ -\mathbf{a} & 1 \end{bmatrix} \begin{bmatrix} \mathbf{X} \\ X_n \end{bmatrix} = \begin{bmatrix} \mathbf{E} \\ 0 \end{bmatrix}. \quad (3')$$

Note that the difference between expression (3) and (3') is that in the latter we isolate the vector of sectoral exports $\mathbf{E} = \xi \bar{X}_n \mathbf{c}^e$ on the right-hand side. We may rewrite system (3') as:

$$\begin{cases} \mathbf{X} - \mathbf{c}X_n = \mathbf{E} \\ -\mathbf{a}\mathbf{X} + X_n = 0 \end{cases}. \quad (10)$$

From the last line of system (10), it follows that:

$$X_n = \mathbf{a}\mathbf{X}. \quad (11)$$

Note that the employment level, X_n , is now not exogenous as in (5) since we are solving the system by considering the possibility of unemployment. That was not admissible for the solution of (5) since, there, the existence of full employment is a necessary condition for the existence of non-trivial solutions. Pre-multiplying throughout the first line of (10) by \mathbf{a} and using (11) yields $\mathbf{a}\mathbf{X} = \mathbf{a}\mathbf{c}\mathbf{a}\mathbf{X} + \mathbf{a}\mathbf{E}$. By isolating $\mathbf{a}\mathbf{X}$, we obtain the employment multiplier relationship:

$$\mathbf{a}\mathbf{X} = \frac{1}{1 - \mathbf{a}\mathbf{c}} \mathbf{a}\mathbf{E}, \quad (12)$$

where $1/1 - \mathbf{a}\mathbf{c}$ is a scalar employment multiplier (Trigg/Lee 2005). This is an employment multiplier relationship between the employment level $\mathbf{a}\mathbf{X}$ and the total labour embodied in exports $\mathbf{a}\mathbf{E}$, where the scalar employment multiplier is $1/1 - \mathbf{a}\mathbf{c}$. Here we can dispense with the assumption of circulating capital in a pure labour economy by Trigg/Lee (ibid.) because we have an exogenous variable, namely $\mathbf{a}\mathbf{E}$, that can be isolated in the income = aggregate demand equation that gives rise to the multiplier. Since $\mathbf{E} = \xi \bar{X}_n \mathbf{c}^e$, expression (12) may be rewritten as:

$$\mathbf{a}\mathbf{X} = \frac{\xi \mathbf{a}\mathbf{c}^e}{1 - \mathbf{a}\mathbf{c}} \bar{X}_n. \quad (12')$$

From expression (7'), $1 - \mathbf{a}\mathbf{c} = \mathbf{a}\mathbf{c}^m$. It is worth remembering that implicit in this expression is the notion of full expenditure of national income. By substituting this result into expression (12'), it can be re-expressed as

$$\mathbf{a}\mathbf{X} = \frac{\xi \mathbf{a}\mathbf{c}^e}{\mathbf{a}\mathbf{c}^m} \bar{X}_n. \quad (12'')$$

This result shows that if the balance-of-payments equilibrium condition conveyed by expression (9) is fulfilled, namely $\xi \mathbf{a} \mathbf{c}^e = \mathbf{a} \mathbf{c}^m$, then the employment level is equal to the full employment level, $\mathbf{a} \mathbf{X} = \bar{X}_n$.

Further scrutiny of this result allows us to conclude that the full employment of the labour force will be reached when both the condition of full expenditure of national income and the balance-of-payments equilibrium are simultaneously satisfied. Another way of showing this result is to note that if $\xi \mathbf{a} \mathbf{c}^e = \mathbf{a} \mathbf{c}^m$ and $1 - \mathbf{a} \mathbf{c} = \mathbf{a} \mathbf{c}^m$ then $1 - \mathbf{a} \mathbf{c} = \xi \mathbf{a} \mathbf{c}^e$, which is the full employment condition given by expression (7'). The rationale for this result may be grasped considering two main possibilities. Assume, first, that the condition of full expenditure is satisfied, namely $1 - \mathbf{a} \mathbf{c} = \mathbf{a} \mathbf{c}^m$, but there is a trade imbalance in the sense that imports are higher than exports, that is, $\xi \mathbf{a} \mathbf{c}^e < \mathbf{a} \mathbf{c}^m$. In this case, $1 - \mathbf{a} \mathbf{c} > \xi \mathbf{a} \mathbf{c}^e$ which implies that $\mathbf{a}(\mathbf{c} + \xi \mathbf{c}^e) < 1$, meaning unemployment. In this case, although the national income is fully expended, the content of labour in the exports is lower than the content of labour in the imports, which gives rise to unemployment.

The other possibility is connected to the case in which trade is balanced but the national income is not fully expended. Hence $\xi \mathbf{a} \mathbf{c}^e = \mathbf{a} \mathbf{c}^m$ but $\mathbf{a}(\mathbf{c} + \mathbf{c}^m) < 1$. It is easy to show that this case leads to $\mathbf{a}(\mathbf{c} + \xi \mathbf{c}^e) < 1$, also meaning unemployment. Then it is proven that the full employment of the labour force depends on the conjunction of two other conditions, namely full expenditure of national income and balance-of-payments equilibrium.

This result shows that if the effective demand condition given by expression (5) is fulfilled, then the employment level is equal to the full employment level, namely $\mathbf{a} \mathbf{X} = \bar{X}_n$. While expression (12') generates different levels of employment, only one of them will be the full employment level that corresponds to the Pasinettian solution. Through further decomposition (see Trigg 2006: appx 2), (12) can be substituted into the first line of (10) to yield:

$$\mathbf{X} = \left(\mathbf{I} + \frac{\mathbf{c} \mathbf{a}}{1 - \mathbf{a} \mathbf{c}} \right) \mathbf{E}. \quad (13)$$

From expression (7'), $\mathbf{a} \mathbf{c}^m = 1 - \mathbf{a} \mathbf{c}$. Hence:

$$\mathbf{X} = \left(\mathbf{I} + \frac{\mathbf{c} \mathbf{a}}{\mathbf{a} \mathbf{c}^m} \right) \mathbf{E}. \quad (14)$$

This is a multiplier relationship between the vector of gross outputs, \mathbf{X} , and the vector representing foreign demand, \mathbf{E} , where $\left(\mathbf{I} + \frac{\mathbf{c} \mathbf{a}}{\mathbf{a} \mathbf{c}^m} \right)$ is the output multiplier matrix. This result is a multi-sectoral version of the Harrod foreign trade multiplier whereby the output of each sector is related to the export performance of that sector. One of the main differences between this multi-sectoral multiplier for an open economy and the one derived by Trigg/Lee is that the latter is a scalar, and the former is a matrix.

The derivation of the multi-sectoral Harrod foreign trade multiplier allows us to better understand the connection between the balance of payments and the levels of employment and production. Expressions (12') and (14) show that balance-of-payments equilibrium may be associated with levels of employment and production lower than those related to full employment and equilibrium. In order to show this, let us rewrite (14) by considering that $\mathbf{E} = \xi \bar{X}_n \mathbf{c}^e$. After some algebraic manipulation, this yields:

$$\mathbf{X} = \left(\xi \mathbf{c}^e + \mathbf{c} \frac{\xi \mathbf{a} \mathbf{c}^e}{\mathbf{a} \mathbf{c}^m} \right) \bar{X}_n. \quad (14')$$

Expression (14') plays a central role in our analysis. It shows that if $\mathbf{a} \mathbf{c}^m = \xi \mathbf{a} \mathbf{c}^e$, then the solution given by (14') sums up to the solution given by the first line of (5). In this

vein, the equilibrium Pasinettian solution given by the first line of expression (5) is a particular case of the solution given by multi-sectoral Harrod foreign trade multiplier (14') when there is an equilibrium balance of trade, $\mathbf{ac}^m = \xi \mathbf{ac}^e$.

Hence the solution put forward by Araujo/Teixeira (2004) for an open version of the Pasinetti model is in fact a particular case of the solution obtained here. That result is of key importance. Note that if $\xi \mathbf{ac}^e > \mathbf{ac}^m$, such that $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m} > 1$, a situation in which the country is running trade surpluses, we should expect that the levels of output given in the Harrodian solution given by (14') are higher than the Pasinettian solution given by the first line of (5). Otherwise, if the country is running trade deficits, that is, $\xi \mathbf{ac}^e < \mathbf{ac}^m$, this implies that $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m} < 1$, and outputs in the Pasinettian solution are higher than in the Harrodian solution. In sum, we should expect that the sectoral outputs given by the Harrod foreign trade multiplier deviate from the equilibrium Pasinettian output in the presence of trade deficits and surpluses.

But one of the main arguments of BPCG theory is that, while short-run deviations from balance-of-payments equilibrium are possible, in the long run trade should be balanced, namely $\xi \mathbf{ac}^e = \mathbf{ac}^m$, since a country cannot run permanent deficits. While the case $\xi \mathbf{ac}^e < \mathbf{ac}^m$ is unsustainable from the viewpoint of country *U* in the long run, the reverse $\xi \mathbf{ac}^e > \mathbf{ac}^m$ is unsustainable from the viewpoint of country *A*. Then, from expression (14'), we may conclude that although there can be sectoral output deviations from the equilibrium level in the short run, there is a trend in the long run that such deviations are not cumulative; hence we expect that the Harrodian solution gravitates around the long-run Pasinettian solution.⁵

4 FROM THE MULTI-SECTORAL TO AN AGGREGATE VERSION OF THE STATIC HARROD FOREIGN TRADE MULTIPLIER

In order to further develop the relationship between the Pasinettian model and the international trade literature, it may be shown how the aggregate version of the static Harrod foreign trade multiplier can be derived from the analysis developed in the previous section. Now under a pure labour theory of value, as assumed by Pasinetti, let us say that there is a wage unit, $w = 1$, such that money prices are equal to labour coefficients. From the first line of system (8) we conclude that $\mathbf{p} = \mathbf{a}$. By substituting this result into expression (12), a scalar output multiplier relationship can be specified as follows:

$$\mathbf{pX} = \frac{1}{1 - \mathbf{pc}} \mathbf{pE}. \quad (15)$$

Note that \mathbf{pX} amounts to total money output, namely $Y = \mathbf{pX}$, and \mathbf{pE} represents total money exports, that is $E = \mathbf{pE}$. Hence, expression (15) takes the form:

$$Y = \frac{1}{1 - \mathbf{pc}} E. \quad (16)$$

5. The idea is that the difference between expressions (5) and (14') rests on the quotient $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m}$. If trade is balanced, then $\mathbf{ac}^m = \xi \mathbf{ac}^e$, which implies that $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m} = 1$, meaning that expressions (5) and (14') are identical. Our point, based on the balance-of-payments equilibrium viewpoint, is that although disequilibria in trade are possible and even expected in the short run (a situation in which $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m} > 1$), in the long run trade must be balanced, which implies that $\frac{\xi \mathbf{ac}^e}{\mathbf{ac}^m} = 1$.

This is an aggregate multiplier equation in which \mathbf{pc} is the propensity to consume domestically produced goods. Expression (16) is analogous to the aggregated Harrod foreign trade multiplier since it relates output to total exports. But in order to prove that this is the Harrod multiplier it is necessary to show that the denominator embodies the propensity to import. By also substituting $\mathbf{p} = \mathbf{a}$ into expression (4'), one obtains $\mathbf{p}(\mathbf{c} + \xi\mathbf{c}^e) = 1$, which yields $\xi\mathbf{pc}^e = 1 - \mathbf{pc}$. By substituting this result into expression (16), one obtains:

$$Y = \frac{1}{\xi\mathbf{pc}^e} E. \quad (17)$$

A key assumption to derive the static Harrod foreign trade multiplier is that of trade balance. By also substituting $\mathbf{p} = \mathbf{a}$ into expression (9), the trade balance equation is derived in terms of prices, meaning that in a pure labour economy there is equivalence between the trade balance equilibrium in terms of prices and in terms of labour: $\mathbf{p}(\xi\mathbf{c}^e - \mathbf{c}^m) = 0$, which yields: $\xi\mathbf{pc}^e = \mathbf{pc}^m$. By substituting this result into expression (17), one obtains:

$$Y = \frac{1}{\mathbf{pc}^m} E. \quad (18)$$

The denominator of this multiplier is the scalar $m = \mathbf{pc}^m$, representing the propensity to consume imports, as first introduced in (1). The main contribution here is that this propensity to consume is derived from Pasinettian multi-sectoral foundations – instead of from an aggregate national income equation, as in the original Harrod formulation reported in Section 2. Though the propensity to import is a scalar magnitude, it is aggregated by pre-multiplying the column vector of import consumption coefficients (\mathbf{c}^m) by the row vector of money prices (\mathbf{p}). This aggregate relationship holds regardless of the number of sectors (number of vector elements).

Expression (18) represents a Harrod trade multiplier that, to use a notion introduced by Pasinetti (1981: 35) is 'truly macro-economic'. He writes: 'There are relations, in economic analysis, which take up a macro-economic form only when the analysis itself is carried out at a macro-economic level. These relations are macro-economic only artificially. They cease to be macro-economic as soon as the analysis is carried out at a more disaggregated level. But there are other relations which maintain a macro-economic form quite irrespective of the degree of disaggregation at which the analysis is carried out. It is these relations only that may be termed as *truly* macro-economic' (ibid.). On this basis it can be argued that the original Harrod aggregate equation suffers from Pasinetti's critique, that use of such an aggregate model, solely from macroeconomic foundations, is somewhat artificial, compared to our alternative multiplier derived here from Pasinetti's system.

This derivation also contributes to another dimension of the Pasinetti research programme, which is to use his multi-sectoral foundations as a basis for a synthesis between different strands of economic theory.⁶ The 'basic elements ... can be traced back to various stages in the development of economic thought' (Pasinetti 1981: 19). One such basic element is the Kahn employment multiplier, developed by Kahn (1931), which in *The General Theory* Keynes (1936) acknowledged to be the first formal multiplier framework. We will derive this multiplier, and show how it relates to the Pasinetti system.⁷

6. It should be noted that Pasinetti's approach is both inspired by Schumpeter's approach and at the same time critical that it lacked 'analytical expression'. The approach here provides some analytical foundations that could be developed in a Schumpeterian direction.

7. We are very grateful to an anonymous referee for suggesting that we examine the relationship between the Kahn and Harrod multipliers.

Assume now that the economy produces investment goods too (in contrast to the Harrod system where only goods for consumption and export are produced). Define \mathbf{A} as a column vector of physical new investment goods. Kahn was interested in the primary employment generated by new investment; this can be measured by pre-multiplying the investment vector by the row vector of employment coefficients to give \mathbf{aA} . Using domestic consumption coefficients (\mathbf{c}) to relate consumption to employment (\mathbf{aX}), the labour required to produce total consumption is defined as $\mathbf{ac(aX)}$. Hence total employment is defined by the relationship:

$$\mathbf{aX} = \mathbf{ac(aX)} + \mathbf{aA}, \quad (19)$$

from which the Kahn multiplier relationship is defined according to:

$$\mathbf{aX} = \frac{1}{1 - \mathbf{ac}} \mathbf{aA}. \quad (20)$$

The Kahn multiplier – a genuinely macroeconomic version – is equal to $1/1 - \mathbf{ac}$. Now since in the Pasinetti system, as we have seen, $\mathbf{p} = \mathbf{a}$, by comparing (20) with equations (16) to (18) we can see that the Kahn and Harrod multipliers are identical. Though there is no role for exogenous investment in the Pasinetti pure labour system, the investment–employment multiplier developed by Kahn, in a different system from that of Harrod, is nested in the Pasinetti system as extended here – further testament to the remarkable synthetic potential of Pasinetti’s system as a foundation for different modelling approaches.

It should also be noted, by inspection of (13), that this Harrod–Kahn aggregate multiplier is integral to the matrix multiplier developed in Araujo/Trigg (2015). Far from being an aggregate alternative to multi-sectoral structural change analysis, the aggregate multiplier is nested as a constituent part of the full-blown disaggregated model. For an analysis of the impact, for example, of export expansion in a particular sector i , the impact on other sectors consists of an aggregate multiplier component ($1/1 - \mathbf{ac}$), and a disaggregated component using the first column of the matrix \mathbf{ca} (see equation (13)).

This decomposition of the Harrod matrix multiplier offers the basis for further extensions. Though as an abstract starting point the model developed here is based on pure labour foundations, Pasinetti (1981) has shown how this framework can be translated into an input–output framework which models intermediate capital flows. Since world input–output tables have become readily available to researchers and policymakers in recent years, the possibility is opened up of estimating Harrod multipliers, in matrix and aggregate form. Whilst the truly macroeconomic Harrod multiplier provides a headline indicator of the overall macroeconomic impact of exports – of accessible macroeconomic appeal to policymakers – this can also be nested in a more disaggregated framework which looks at structural change. The decomposition of the multiplier framework suggested here, though firmly theoretical in its objectives, provides a possible starting point for tailoring the modelling approach to empirical research.

5 CONCLUDING REMARKS

The paper follows the Kaldorian view that output and output growth are determined by external constraints, and once income is determined, variables such as saving and capital accumulation are determined accordingly. Such an approach considers that the driving force of growth is demand and not supply, and in this sense it disregards other constraints

such as saving and capital capacity. Here we provide foundational connections between the SED and BPCG approach by showing that a disaggregated version of the static Harrod foreign trade multiplier may be derived from an open version of the Pasinettian model. In this vein, we have also introduced a derivation of the dynamic Harrod foreign trade multiplier that is completely new in its formulation. The paper also demonstrates how this multiplier is an integral part of the decomposed matrix Harrod multiplier. In addition, we show that the equilibrium Pasinettian solution for the system of physical quantities may be obtained as a particular case of the solution given by the multi-sectoral Harrod foreign trade multiplier, derived when the full employment condition is satisfied. Finally, in order to prove the consistency of our approach, we show that departing from this disaggregated version of the Harrod foreign trade multiplier we can obtain the aggregate version. With the approach developed here, the outcomes from cross-fertilization between the two approaches extend beyond the disaggregated version of Thirlwall's law.

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