

Money and Value in Ricardo: A Pasinetti-based Formalisation

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Introduction

Ricardo is usually interpreted as being an adherent to the quantity theory of money: a perception based on his analysis of currency over issue in the great bullion controversies of the early nineteenth century. Since Ricardo is just one of many to write on the quantity theory, 'he is apt to be considered a rather minor figure in the history of monetary thought' (Takenaga 2013, 15.8). To make matters worse, Ricardo's investigations in monetary theory have been perceived as unhinged from his study of value and distribution. As reported by Marcuzzo and Rosselli (1994, p. 425), 'Ricardo is criticised for basing the determination of money prices both on the quantity theory of money, and on the labour theory of value, without being aware of the inconsistency'. For some this is because Ricardo 'turned away from monetary issues' once issues of value and distribution had caught his attention (Peake 1978, p. 193).

To explore these issues, 1816 can be considered as a significant year in which Ricardo worked on the development of both monetary and value theory. First, Ricardo published his *Proposals for an Economic and Secure Currency* (1816), in which he argues that the medium of circulation should be made up entirely of banknotes, underpinned by the mint price of gold. As argued in the so called 'new interpretations' of Ricardo (Sato 2013), in the *Proposals* a move away from the quantity of theory of money can be identified, with the volume of banknotes endogenously dependent on the scale of economic activity. Second, Ricardo had something of an epiphany that year, in drafting *On the Principles of Political Economy and Taxation* (1817). The labour time required to produce commodities previously had a role as one amongst several influences on value; in 1816 Ricardo decided upon embodied labour as the fundamental basis for value.

To contribute to our understanding of these different dimensions in Ricardo's thought, an abstract system is developed here that quantifies both value and money. This is attempted by adapting the classical model of pure labour developed by Pasinetti (1993). With labour as the sole factor of production, this system offers a simplified starting point for formally exploring how aspects of Ricardo's monetary analysis might fit with his theory of value and distribution.

The paper starts by introducing the Pasinetti pure labour model as a multisectoral framework for formalising aspects of Ricardo's system. In the second part, the role money is introduced, with particular emphasis on the determination of prices. In the third part a framework is developed for considering how the quantity of money is determined, by considering the relationship between the central bank and commodity producers. In the final part some conclusions are suggested.

The Pure Labour Model

Pasinetti (1993) develops a production model for which, in the classical tradition following Adam Smith, there is an advanced social division of labour. The key way in which this resembles the approach of Ricardo is in its specification of embodied labour coefficients (l_i) for each commodity i . In a pure labour setting, where labour is the sole factor of production, and there are no other capital inputs, labour coefficients define the amount of direct labour required to produce each unit of physical output (Q_i). As stated by Ricardo (1817, p. 32) in the first chapter of his *Principles*: 'If men employed no machinery in production but labour only, and were all the same length of time before they brought their commodities to market,

the exchangeable value of the goods would be precisely in proportion to the quantity of labour employed.’ Similarly in his later *Absolute Value and Exchangeable Value*: ‘It appears then that we should have no difficulty in fixing on a measure of value, or at least in determining on what constituted a good measure of value, if all commodities were produced exactly under the same circumstances – that is to say if all required labour only without advances, to produce them...’ (Ricard 1823, p. 368). As specified by Ricardo under this extreme assumption, it will be assumed that all unassisted labour is used up over the course of the same period of production.

Ricardo is also concerned, in the first chapter of the *Principles*, about the difference between his labour embodied approach to value and the labour commanded approach of Adam Smith and Malthus. It so happens, as shown by Pasinetti (1993, p. 19), that in the pure labour model, labour embodied categories are also indistinguishable from the alternative labour commanded categories. This approach is of course an extreme starting point for Ricardo’s value theory. ‘The two extremes appear to be these: one, where the commodity is produced without delay, and with labour only, without the intervention of capital...’ (Ricardo, 1820, p. 193). In the famous beaver and deer example (see Ricardo 1817, p. 13), pure labour conditions would require each hunter to kill their prey with their bare hands. However, we can proceed knowing from Pasinetti (1981) that the pure labour model can in principle be extended at a later stage to include capital inputs; Pasinetti views the pure labour approach as a theoretical device for identifying economic structures that may not be discernible in a more complex setting.

Though labour specialises in the production of a particular commodity, it also purchases all of the other commodities produced across m industrial sectors. The consumption coefficient c_i defines the quantity of physical quantity of good i consumed per unit of homogeneous labour. Assuming a closed economy, with no exports or imports, the quantity system for the Pasinetti model takes the form:

$$Q_i = c_i N \quad , i = 1, \dots, m \quad (1)$$

$$N = l_1 Q_1 + l_2 Q_2 + \dots + l_m Q_m \quad (2)$$

Equation (1) shows how the outputs of each sector depend on the volume of total employment (N). In (2) total employment is dependent on quantities of output produced throughout the production economy. For simplicity, in developing our monetary analysis, it will be assumed that production in each single commodity producing sector is carried out by one individual producer: the corn sector is represented by a farmer, the clothing sector by a tailor, the bread making sector by a baker, etc. This excludes money circulation between producers in each sector, an assumption that could be relaxed at a more complex stage of analysis.

The dual price system then takes the form:

$$p_i = wl_i \quad i = 1, \dots, m \quad (3)$$

$$w = p_1c_1 + p_2c_2 + \dots + p_m c_m \quad (4)$$

In (3) a pure labour theory of value is established, with money prices per unit of physical output (p_i) proportional to labour coefficients according to the scalar uniform wage rate (w).

In keeping with Ricardo's rejection of hoarding as a theoretical possibility (see Takenaga 2013, p. 80), all of this money wage is spent on consumer expenditures, as captured in (4).

Substituting either (1) into (2) or (3) into (4) gives the macroeconomic condition

$$l_1c_1 + l_2c_2 + \dots + l_m c_m = 1 \quad (5)$$

This is an equilibrium condition for solution to the Pasinetti quantity and price systems. In the analysis that follows, Ricardo's monetary writings will be interpreted by first looking at money prices in the price system, followed secondly by a consideration of economic quantities.

Price Regulation

Ricardo introduces money as a circulating medium in order to facilitate exchange between producers. This medium of exchange had throughout the eighteenth century been underpinned by silver and gold bullion. Metal coins were minted from bullion and exchanged between producers; the Bank of England issued notes which were convertible into coins that could be melted back into bullion. In the crisis of the late 1790s, however, a run on the Bank led to a shortage of coins (and bullion to mint them) to meet the demands of the public, and in response convertibility was suspended under the 1797 Restriction Act.

Ricardo first started writing about economics because of the rise in the price of bullion following restriction. As Sraffa (1951a, p. 3) reports, the price of gold rose on two key occasions, from 1799 to 1801, and once more in 1809. In a series of newspaper articles collected in *The Price of Gold* (1809), and in the pamphlet *The High Price of Bullion* (1810-11), Ricardo identified the key problem as being the deviation of the market price of gold from its mint price. 'Whilst the Bank pays its notes in specie, there can never be any great difference between the mint and market-prices of gold' (Ricardo 1809, p. 15). But when notes are issued that are not convertible back into coins, the price of gold is allowed to float freely.

In response, Ricardo came up with the Ingot Plan, as it came to be called, first formulated in the Appendix to *The High Price of Bullion*, and fleshed out in more detail in Ricardo's (1816) *Proposals for an Economic and Secure Currency*. Since metal coins can be clipped, costly to transport, and costly to produce in terms of labour expense and required bullion, Ricardo favours banknotes as a medium of circulation. By setting a mint price for this convertibility, it is argued the price of gold can be anchored by Bank of England regulation. Deleplace (2013, p. 115) has described this as a 'normative conception of an ideal money system', one

which became influential throughout the world in subsequent developments of central banking and gold standard regimes.

The Ingot Plan was further embraced in Ricardo's *On the Principles of Political Economy and Taxation* (1817); in the second and third editions, the chapter 'On Currency and Banks' includes an extensive extract from the *Proposals*. But one key difference can be highlighted: Ricardo had at this point also embraced an embodied labour theory of value. It is well known, as discussed by Sraffa (1951b, p. xxx), that Ricardo developed this theory in response to difficulties involved with defining value in his *Essay on Profits* (1815). Also important is the nascent role given to labour embodied values in Ricardo's earlier monetary writings. Intrinsic value depends in part on labour expended: 'Gold and silver, like other commodities, have an intrinsic value, which is not arbitrary, but is dependent on their scarcity, the quantity of labour bestowed in procuring them, and the value of the capital employed in the mines which produce them' (Ricardo 1810-11, p. 52). It is also clear that the value of gold and silver depends on 'the difficulty of working the mines' (Ricardo 1816, p. 56). Only in the *Principles*, however, do we see the clear statement that labour is the key determinant of value: 'Gold and silver, like all other commodities, are valuable only in proportion to the quantity of labour necessary to produce them, and bring them to market' (Ricardo 1817, p. 352).

The relative values of all commodities are governed by the labour expended on their production. But for Ricardo (1817, p. 43): 'When commodities varied in relative value, it would be desirable to have the means of ascertaining which of them fell and which rose in real value, and this could be effected only by comparing them one after another with some invariable standard measure of value, which should itself be subject to none of the fluctuations to which other commodities are exposed.' Ricardo faced a number of difficulties in his quest for such an invariable standard, including issues relating to the proportion and durability of fixed and circulating capital (see Ricardo 1817, p. 45). But in the pure labour model developed here, we abstract from these issues as a preliminary step to throw some light on the analytical core of Ricardo's monetary system. Under pure labour conditions, gold provides a perfect candidate for being the invariable standard under a key assumption: 'that the same quantity of labour to be always required to obtain the same quantity of gold...'. (Ricardo 1817, p. 44).

This assumption can be incorporated into the Pasinetti model by letting gold (commodity g) be one of the m commodities produced by the system and l_g represent the labour time required to produce each ounce of gold – the labour value of gold. Ricardo's key assumption for gold to be an invariable standard is that the labour value of gold is a fixed magnitude.

On this basis, with the intrinsic value of gold defined by the labour required for its production, a model of Ricardo's normative plan can be developed.¹ As a starting point, consider Pasinetti's price equation (3) in which money prices are proportional to values according to a scalar money wage rate. The money wage rate can be re-expressed as²

$$w = \frac{\alpha}{l_g} \tag{6}$$

so that instead of (3) we have

$$p_i = \alpha \frac{l_i}{l_g} \quad (7)$$

This alternative price equation consists of two parts. In the second part, dividing the labour value of each commodity (l_i) by the labour value of gold (l_g) gives us an expression showing a gold/commodity ratio l_i/l_g for each commodity i : the gold price of this commodity. This can be illustrated by letting commodity 1, for example, represent corn. If say 12 units of labour are required to produce a bushel of corn, and it takes 4 units of labour to produce an ounce of gold, then the gold/commodity ratio is $12/4 = 3$: the gold price of corn is 3 ounces.

In the first part of (7), α is a money/gold ratio. Money is a unit of currency such as pounds sterling. In our example, let the money price of an ounce of gold be £2: the money/gold ratio is 2 pounds per ounce of gold. Following the approach of Marcuzzo and Roselli (1994), for each commodity i the price equation can be understood as:

$$\text{Money price of commodity} = \text{money/gold} \times \text{gold/commodity} \quad (8)$$

In the corn example, the money price is hence £6 per unit of corn, a multiple of £2 (the money/gold ratio) and 3 (the gold/commodity ratio).³ Note that under $\alpha = 1$ the system would be reduced to a commodity money economy in which the prices of commodities were measured in units of an actual commodity, gold – in our example the price of corn would be its gold price, 3 ounces of gold. When instead $\alpha > 1$, a money economy is established in which gold is still the underlying standard, but prices are measured in units of currency (£6 per unit of corn).

Exploring the structure of this system in more detail, consider now the price equation for the commodity gold:

$$p_g = \alpha \frac{l_g}{l_g} = \alpha \quad (9)$$

With the labour value of gold being divided by itself, the gold/commodity ratio is equal to 1, which means that the money price of gold (p_g) is equal to the money/gold ratio, α . Thus the price of each commodity, as specified in equation (7), is dependent upon the money price of gold:

$$p_i = p_g \frac{l_i}{l_g} \quad (10)$$

(Money price of commodity = money price of gold x gold price of commodity)

There are, therefore, two determinants of the money price of a commodity. The first is the money price of gold; it was fluctuations in this price (the high price of bullion) that Ricardo worried might threaten the stability of the pound. Second, it depends on the value of the commodity measured in units of the standard (the gold price of the commodity), as calculated by the ratio of the labour value of the commodity to the labour value of the standard.

Since the labour value of gold is assumed to be a fixed magnitude, Ricardo focuses on how to ensure stability in the money price of gold, as determined in the markets. Core to this stability is the proposal that convertibility of the currency to gold be restored at the mint price. To ‘attain the most perfect state to which a currency can be brought’, the Bank should be subject ‘to the delivery of uncoined gold and or silver at the Mint standard and price, in exchange for their notes...’ (Ricardo 1816, quoted in Ricardo 1817, p. 357). The normative system involves no coins: just banknotes and bullion.

In our above example, the money price of an ounce of gold, as determined in the markets, is £2. Let’s say at the outset that this is also the mint price of gold.⁴ It may be assumed that individuals are able to sell an ounce of gold to the Bank of England at this mint price, in return for two pound notes; and are able to purchase an ounce of gold from the Bank, also in exchange for two pound notes. If the money price of gold drifts in the markets below this mint price, say to £1, the following will happen. Under arbitrage, individuals will be able to purchase an ounce of gold on the markets for one pound note and sell it to the Bank for two pound notes – making a £1 profit on each ounce. If on the other hand the market price of gold increases to £3 per ounce, individuals can purchase an ounce of gold from the Bank at the mint price of £2 and then sell the gold in the markets for £3 – also making a profit of £1 per ounce. Ricardo reasons, however, that either situation of arbitrage will force the market price of gold back towards the mint price. If the market price is above the mint price, the selling of gold on the markets will force the market price downwards towards the mint price; if the market price is below the mint price, the purchasing of gold on the markets will force the market price back up towards the mint price. The market price of gold is regulated by a mint price set by the Bank of England. In the Ingot Plan, a return to the mint value of gold bullion at £3. 17s. 101/2d. per ounce was proposed (Ricardo 1809, p. 124).

Hence, in (10) the Bank ensures that the money price of gold (p_g) is set equal to the mint price (\bar{p}_g), such that Pasinetti’s price equation can be re-expressed as

$$p_i = \bar{p}_g \frac{l_i}{l_g} \quad (11)$$

Given conditions of production for all commodities, including gold, as reflected in the labour coefficients, Ricardo’s policy for price stability of each good i is thus to regulate the market price of gold using the mint price. So long as gold is freely converted into notes, and notes converted into gold, the forces of demand and supply automatically ensure that the money price of gold converges to the mint price. If this regulatory system is effective any changes in the money price of a commodity cannot be caused by monetary forces; only changes in the conditions of production can impact on prices.

The Quantity of Money

On this ‘new’ interpretation of Ricardo, the Bank of England directly regulates the price and *not* the quantity of money. ‘The issuers of paper money should regulate their issues solely by the price of bullion, and never by the quantity of their paper in circulation.’ (Ricardo 1816, p. 64). Money is endogenous, its quantity established in response to the requirements of circulation via a price signal rather than a quantity signal (see Rosselli (1999, p. 150)).⁵ This can be formally shown by multiplying the price equation (11) by Q_i , the physical output of good i , such that

$$p_i Q_i = \bar{p}_g \frac{l_i}{l_g} Q_i \quad (12)$$

If for simplicity each pound note is assumed to circulate around the economy only once (a velocity of circulation of 1), by aggregating across all m sectors we have

$$M = \sum_{i=1}^m p_i Q_i = \frac{\bar{p}_g}{l_g} \sum_{i=1}^m l_i Q_i \quad (13)$$

The total volume of money banknotes (M) circulating in the economy depends on three factors, as specified on the right hand side of (13): the mint price of gold (\bar{p}_g), the labour value of gold (l_g), and the total quantity of labour (total employment) expended in the

economy as a whole, $\sum_{i=1}^m l_i Q_i$. The first of these is a monetary price signal set by the Bank,

whilst the other two elements are generated by the conditions of production and the level of economic activity in the real economy.

Hence in Ricardo’s Ingot Plan, as formalised here using Pasinetti’s system, there is no role for the total money supply as an independent variable – a key plank of the quantity theory of money, as defined by Schumpeter (1954, p. 703). As argued by Marcuzzo and Rosselli (1994), this provides a response to the criticism that Ricardo unsuccessfully tries to marry the labour theory of value with the quantity theory of money (De Vivo, 1987). Under convertibility between gold and banknotes in the Ingot Plan, relative prices are determined by labour values *without* a quantity theory of money.⁶

This insight can be further developed in relation to Pasinetti’s quantity system. Whereas the price system has been closed here by an exogenously set mint price, closure is also required of the quantity system. Closure of the quantity system requires that we fix either the level of employment (see Pasinetti 1993, p. 18), or alternatively the output level of one of the m industrial sectors. As part of his Classical-Keynesian approach, Pasinetti closes the quantity system by allowing a central planner to set the level of full employment. This type of government intervention in the sphere of trade and production might be ruled out, however, under the auspices of Ricardo’s liberal economic approach. Throughout his parliamentary and intellectual career, Ricardo was largely against intervention by government, for example

under Poor Laws and Corn Laws. He refers to the ‘benefits resulting to a country from the liberty of trade, leaving every man to employ his talents, and capital, as to him may seem best, unshackled by restrictions of every kind’ (Ricardo 1816, p. 70). More in keeping with Ricardo’s approach, the quantity system can instead be closed by fixing the output level of one the producers, say producer 1. Producers in other sectors may be assumed to produce levels of output that are consistent, via equations (1) and (2), with the output of producer 1.

Once output levels are defined in the quantity system, money flows between producers can be established, as shown in Table 1, with employment in each sector defined as $N_i = l_i Q_i$.

Money flows, for example from producer 2 to producer 1 of $p_1 c_1 N_2$, are made as payment for output of commodity 1 sent by producer 1 to producer 2. Each element of Table 1 represents a flow of money between producers. Moreover, the row and column totals all sum up to the total volume of money (M) required to circulate in this economy within one production period.

Table 1 Money flows between producers

	1	2	...	m	Total
1	$p_1 c_1 N_1$	$p_1 c_1 N_2$	...	$p_1 c_1 N_m$	$p_1 Q_1$
2	$p_2 c_2 N_1$	$p_2 c_2 N_2$	...	$p_2 c_2 N_m$	$p_2 Q_2$
⋮	⋮	⋮	⋮	⋮	⋮
m	$p_m c_m N_1$	$p_m c_m N_2$	...	$p_m c_m N_m$	$p_m Q_m$
Total	$p_1 Q_1$	$p_2 Q_2$	...	$p_m Q_m$	M

In Ricardo’s Ingot Plan, these money flows may be represented by convertible banknotes issued by the Bank of England. The question then arises, how are these banknotes distributed by the central bank to producers? Ricardo (1810-11, p. 54) refers to the Bank’s ‘power of issuing its notes for a circulating medium; after a large amount had been issued by way of loan to merchants’. Building on this insight, we will assume that producers take out loans from the central bank in order to borrow banknotes required for circulation.⁷ There are no other banks apart from the central bank (The Bank of England) in this system. The Bank is able to ‘lend the notes’ (Ricardo 1810-11, p. 91), but in addition to keep things simple it will be assumed that zero interest is charged on these loans.

A central bank balance sheet for flows of loans and banknotes is provided in Table 2.⁸ These are *ex-ante* flows, which specifically means that they take place during the production period – before the end of the production period. Producers take out loans with the central bank, and

these become assets of the central bank. These loans are IOUs, which producers promise to settle at the end of the production period. In return the producers receive banknotes from the central bank: promises to pay out at any time gold bullion at the mint price. Hence these notes appear on the balance sheet as liabilities of the central bank. Conversely, for the balance sheet of producers (Table 3), the loans appear as liabilities and the banknotes as assets.

Table 2 Balance Sheet for Central Bank (Flows)

	Assets	Liabilities
<i>Ex-ante</i>	Loans to producers (M)	Banknotes (M)
<i>Ex-post</i>	0	0

Table 3 Balance Sheet for Producers (Flows)

	Assets	Liabilities
<i>Ex-ante</i>	Banknotes (M)	Loans to producers (M)
<i>Ex-post</i>	0	0

These banknotes are required by producers in the multisectoral economy, as shown in Table 1. Each producer uses banknotes to purchase commodities from other producers, with the total number of banknotes required summing to M . To model how finance and production interrelate, a simple type of process analysis can be employed, as developed in a more complex setting by Meade (1993) and Dalziel (1996). The aggregate flow of banknotes can be broken down into four stages (Table 4). First, the banknotes are issued to producers, becoming in the second stage the *ex-ante* money income of these producers. In the third stage, each producer uses this income *ex-post* to carry out expenditure on commodities sold by other producers. (There are no aggregate savings in the pure labour model). Each producer receives banknotes for its output, and finally producers use these banknotes to pay back loans taken out with the central bank. *Ex-post*, all liabilities and assets are extinguished, as shown by zero entries in the balance sheets of the central bank and producers (Tables 2 and 3).

Table 4 Aggregate Flow of Banknotes, Income and Expenditure

	<i>Ex ante</i>	<i>Ex post</i>
Issue of banknotes	M	
Income	M	
Expenditure		M
Return of banknotes		M

For completeness, a rudimentary balance sheet can be presented for the stocks of the central bank (Table 5). It may be assumed that the central bank has no stock of liabilities, but that it has reserves of gold bullion (G) which appear on the asset side of the balance sheet. These reserves, which constitute the central bank's net worth, are required in order to underpin

Ricardo’s price signal mechanism, in which the central bank buys and sells bullion on demand. But note the system is designed to allow for $M > G$: there is no requirement in the Ingot Plan for gold reserves to match the volume of banknotes issued. As summarised by Ricardo (1810-11, p. 126), in this normative plan ‘there would be an amount of bank money, under the name of bank-notes, as great as the demands of commerce could require, at the same time there would be no more inactive capital in the bank coffers than that fund which the Bank should think it necessary to keep in bullion, to answer those demands which might occasionally be made on them.’ The Ingot Plan, by imposing on the Bank the requirement to impose the mint price of gold on the markets, allows a flexibility in this fractional reserve system, with the scale of the bullion reserve sensitive to the needs of commerce.⁹

Table 5 Central Bank Balance Sheet (Stocks)

Assets	Liabilities	Net Worth
Gold Reserves (G)	0	Gold Reserves (G)

This model of Ricardo’s endogenous money approach has some resemblance to the real bills doctrine considered by Adam Smith (1876, Chapter 2, Book II), which provided the basis for the subsequent Law of Reflux developed by the nineteenth century Banking School (see Le Maux 2012). First, for Smith notes are issued through loans (bills of exchange): ‘It is chiefly by discounting bills of exchange, that is, by advancing money upon them before they are due, that the greater part of banks and bankers issue their promissory notes’ (p. 298). Second, so long as these are ‘real’ bills, based on real productivity activity, there is a reflux mechanism (as it would later be called), between producers and banks. In our model of endogenous money, the loans are taken out by producers, and settled using notes circulating between producers. After circulation has taken place, these notes return back to the central bank. Adam Smith uses the metaphor of water: ‘The coffers of the bank...resemble a water pond, from which, though a stream is continually running out, yet another is continually running in, fully equal to that which runs out..’ (Smith 1876, p. 304).

Building on Thornton (1802), Ricardo (1811, p. 217) took issue with the real bills approach in his *Reply to Bosanquet*: ‘but I deny that there would be a surplus seeking in vain for advantageous employment, and which, not being able to find it, would necessarily either return to the Bank in payment of a bill already discounted, or would prevent an application to them for an advance of money to that amount’. Ricardo offers this critique under suspension of convertibility: ‘If money, however abundantly issued, could retain its value, such might be the [real bill] effects; but as, when once it is brought into circulation, depreciation commences, the employment for the additional sum would retain it in the currency’ (Ricardo, 1811, p. 218). However, as argued by Blaug (1962, p. 203), in the Thornton-Ricardo critique there are problems with the real bills doctrine even under convertibility. Bankers may not be able to ascertain whether bills are real or speculative, and this can be further obscured by the velocity of circulation. The model of endogenous money developed here provides a possible starting point for exploring these issues in future work.

Conclusions

Two hundred years ago, Ricardo developed a sophisticated normative plan for the issue of banknotes instead of coins. In what came to be called the Ingot Plan, the Bank of England was not expected to exogenously control the quantity of money in circulation, but instead ensure that these banknotes were convertible into gold bullion at a fixed mint price – thereby also fixing the market price of gold. The mint price of gold is shown here to determine the price system in Pasinetti's pure labour production model, alongside an embodied labour theory of value. The price of a typical commodity depends on the mint price of gold combined with the labour embodied in that commodity relative to the labour embodied in gold. As a contribution to the 'new interpretations' of Ricardo, a simple mathematical framework is designed to precisely distinguish between the price of gold (from Ricardo's monetary theory) and the conditions of production (from Ricardo's theory of value).

Dual to the price system, Pasinetti's quantity system provides the kernel of demand for banknotes, issued endogenously by the central bank in response to the requirements of the quantity system. In Ricardo's normative plan, these banknotes return back to the central bank after completion of each period of production. This rudimentary endogenous money process provides an alternative perspective to the quantity theory of money that is usually associated with Ricardo's writings. This too offers a mathematical formalisation of the endogenous money perspective adopted in the 'new interpretations' of Ricardo.

This approach also provides the basis for systematic explorations of Ricardo's theories, using pure labour foundations as an analytic starting point. Extension of the Pasinetti model may, for example, include consideration of international trade and money flows, as considered in the Ingot Plan, and the modelling of government open market operations, as promulgated in Ricardo's later monetary writings.

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¹ Ricardo's monetary writings are re-interpreted here from the perspective of the *Principles* (1817), with value strictly defined as labour embodied content: in contrast to Ricardo's *Proposals*, in which an expression such as the 'the value of money' refers to the money price of gold (Ricardo 1816, p. 56).

² The relationship between money and wages is identified by Ricardo (1817, p. 48): 'Money, being a variable commodity, the rise of money-wages will be frequently occasioned by a fall in the value of money.'

³ Expressing this £6 price of the commodity using the original Pasinetti price equation (3), it consists of a money wage of £0.5 paid to each of the 12 units of labour required for its production.

⁴ For simplicity, we do not consider at this abstract stage of analysis some of the more concrete aspects of this policy, such as Ricardo's suggestion that convertibility be restricted to transactions above twenty ounces (Ricardo 1817, p. 357), and the role of seignorage (Ricardo 1817, p. 353).

⁵ This contrasts with the problems incurred when, as in the eighteenth century, the Bank of England tries to respond to the requirements of circulation by minting bullion into coins – a process that creates fluctuations in the market for bullion. In his analysis of Ricardo's writings, Takenaga (2013, section 15.70) thus documents the 'instability of the value of money on the supposition of a purely metallic money circulation...'. For Ricardo (1816, p. 55): 'Amongst the advantages of paper over a metallic circulation, may be reckoned, as not the least, the facility with which it may be altered in quantity, as the wants of commerce and temporary circumstances may require.'

⁶ Further discussion is required, however, of the proposition that the quantity theory of money may have a role to play in Ricardo's monetary writings under suspension of convertibility – the actual circumstance faced by Ricardo during the 1797-1821 period of restriction (see Takenaga 2013, section 15.71).

⁷ Ricardo (1810-11, p. 54) also refers to the issuing of banknotes through 'advances to government.' In the absence of a government sector in the pure labour model, which consists only of individual producers, the role of such open market operations is postponed for future development in a more concrete stage of analysis.

⁸ This rudimentary balance sheet draws on the systematic analysis of early banking and the creation of money by Faure (2013).

⁹ Sato (2013, section 13.86) points out that Ricardo 'warned that the rigid requirements rule, in particular, would destabilize the markets when abnormal demand for liquidity occurred'. In the same passage, Sato also argues that later in the nineteenth century Ricardo was proven right when on three occasions the Bank Charter Act (1844) had to be suspended.