Theorising Optimal Population Between the Wars: the Contribution of Australian Economists

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Abstract: The paper provides a rational reconstruction and critique of certain theoretical analyses by inter-war Australian economists of the impact of population on per capita income. It reviews and criticises the attempt by F.C. Benham in 1930 to apply the Wicksell-Cannan theory of optimal population to Australia. And it highlights Arthur Smithies's novel model of 1938 in which increasing returns in manufactures is invoked to establish the existence of an optimal population in a two-sector framework. The present paper's reconstructions indicate that the apparently simplicity of these 'optimal population' theories belied theoretical difficulties that Benham and Smithies did not fully acknowledge.

1   Introduction

During the inter-war years several Australian economists felt confident that simple economic theory under the rubric of 'optimal population' would be suggestive of an ideal population for Australia. This paper reviews the explorations of 'optimal population' in the period by Frederic Benham and Arthur Smithies, and supplies a rational reconstruction of the theories that they advanced less than rigorously. These rational reconstructions indicate that the apparent simplicity of 'optimal population' theory belied theoretical difficulties that their users did not appreciate.

The paper begins by supplying some historical context for 'optimal population' discussions by reviewing controversies in 1920s Australia over the wisdom and possibility of larger population. The paper then introduces the role of economists by considering their interest in the potential intersection between trade policy and population policy, and the sceptical stance of the 'Brigden Report' to the benefits of population growth. The paper then turns to optimal population theorising proper by outlining Benham's attempt of 1930 to apply Wicksell-Cannan notions of optimal population in Australia. It then expounds the simple, original and resourceful theory of optimal population sketched by Smithies in 1938 that turned upon increasing returns in manufacturing. The paper argues that, in spite of their ingenuity, optimal population theories did not successfully confront the complexity of the issues they unwittingly raised, and notes the retreat of optimal population theorising in the postwar period.

2   The Background: 'Australia Unlimited' versus 'Australia Deserta'

The agitated aftermath of the First World War was a time of 'brave new worlds'. Some countries experienced revolutions. Others adopted Temperance. The visionary creed that Australia largely embraced was 'development', and its manifesto was *Australia Unlimited* of Edwin J. Brady of 1918 (1869–1952), a one-time secretary of the Australia Socialist League, friend of Henry Lawson and publisher of Katherine Mansfield's first short stories. *Australia Unlimited*'s 1083

pages and copious photographs is prefaced by Dorothy Mackellar, author of *A Sunburnt Country*. Its credo is forthright.

> We intend to utilize within the boundaries of our Commonwealth opportunities we have hitherto wasted or left underdeveloped. In this building up there will be opportunities for labour and capital unequalled in the histories of industrial civilisation ... It is the policy which is going to make Australia the richest and most powerful ... nation in the world. (Brady 1918: 101)

Clearly the 'rapid peopling of this great Continent' would be requisite for these ambitions. Brady did not seriously attempt a population target, but flags in passing 100 million (Brady 1918: 159), and at one point urges that Western Australia acquire a population equal to that of England and France combined (Brady 1918: 680).

Brady's tenet of a large population as a concomitant of development was repeatedly given a still more quixotic expression by the then Prime Minister Billy Hughes:

> Increased population [said Hughes] was necessary for Australia, which was one of the most fertile countries in the world, and had an ample rainfall provided that it was conserved. He instanced Mildura and Renmark, which, he declared, were veritable paradises without angels and flaming swords. Mr. Hughes referred also to Burrinjuck, where, he asserted, a good living could be obtained from ten acres of land. He maintained that the Murray Valley was destined to equal the Nile in value of production. (*The West Australian*, 22 August 1921: 7)

Hughes had no very steady estimate of the population that Australia should seek. Sometimes he conjured with 25 million; sometimes around 100 million.[1]

> [Hughes] did not hold with gloomy pessimists that because of geographical causes Australia would never be able to hold a big white population. He believed that some day it would hold a population nearly as big as that of like United States [109 million in 1921]. (*The Brisbane Courier*, 23 September 1921: 7)

The advent of S.M. Bruce as Prime Minister in February 1923 spelt the disappearance from the dispatch box of such ebullient sentiments, but did not end the Nationalist government's goal of a larger population. This was underlined by the £34m 1925 agreement between the Commonwealth and British governments 'to expand settlement in Australia and increase the capacity of already settled areas to support a higher population', and the 1926 Development and Migration Act.

These populationist aspirations were confronted by the gloomy geographer and weird genius Thomas Griffith Taylor (1880–1963), the foundation head of Australia's first university geography department. In a highly influential 1926 paper in the *Geographical Review* of the American Geographical Society, Griffith Taylor (1926: 12) argued that Australia was sparsely populated for good reason: 'The writer sees no reasonable hope of close settlement in most of empty Australia, for the sufficient reason that Nature has not endowed it with a suitable environment. No government can alter this fact'. Griffith records 'no regions better deserve the title of desert than the vast uninhabited (and under present conditions, uninhabitable) areas *[of Australia]*' (1926). These facts, he allowed, 'were unpleasant. Sensible men and

women, however, had to face them. ... The nearest geographical parallel to inmost Australia was the Sahara desert'. He underlined this with numerous photographs of dismal 'gibber plains' (in implicit rebuttal of the cheerful plates of *Australia Unlimited*) and the observation that Australia's 'frontier' – defined as 'one person per four square miles' – had been *retreating* towards the coast since 1900. The empty spaces were becoming emptier still.

Griffith's stony rebuttal of populationist imaginings provoked considerable ire.

> Sir, It was reported the other day that, prior to his departure for the United States of America, Professor Griffith Taylor made the astounding statement that Australia could not carry a population of more than 20,000,000 people! As Schiller says-'E'en the gods rebel in vain against such crass stupidity'. If he said that this wonderful continent of ours could accommodate 200,000,000 he would have been saying something nearer the mark. Why, Queensland alone has room and opportunities for a population of, at least, 60,000,000 people. If the learned professor talks in this wild fashion in America - well, Australia will not get much of an advertisement.
>
> I am, etc.,
> Cremorne. B. HODSON (*Sydney Morning Herald*, 6 November 1928: 8)

The controversy reached the United States, where Australia's Consulate saw fit to rebut Taylor in the *New York Times*,

> I desire to state that efforts of the Commonwealth and State governments in Australia are centred in a policy designed to exploit vast areas awaiting only the advent of settlers to turn virgin country into highly productive land... Australia enjoys generous rainfall, and it is only a question of locking the water for discreet distribution to our rich lands. (quoted in Strange 2008: 130)

With few allies in Australia, Taylor gladly left Sydney University for a position at the University of Chicago (see Strange and Bashford (2008) and Powell (1993) for accounts of Taylor's confrontation with populationists).
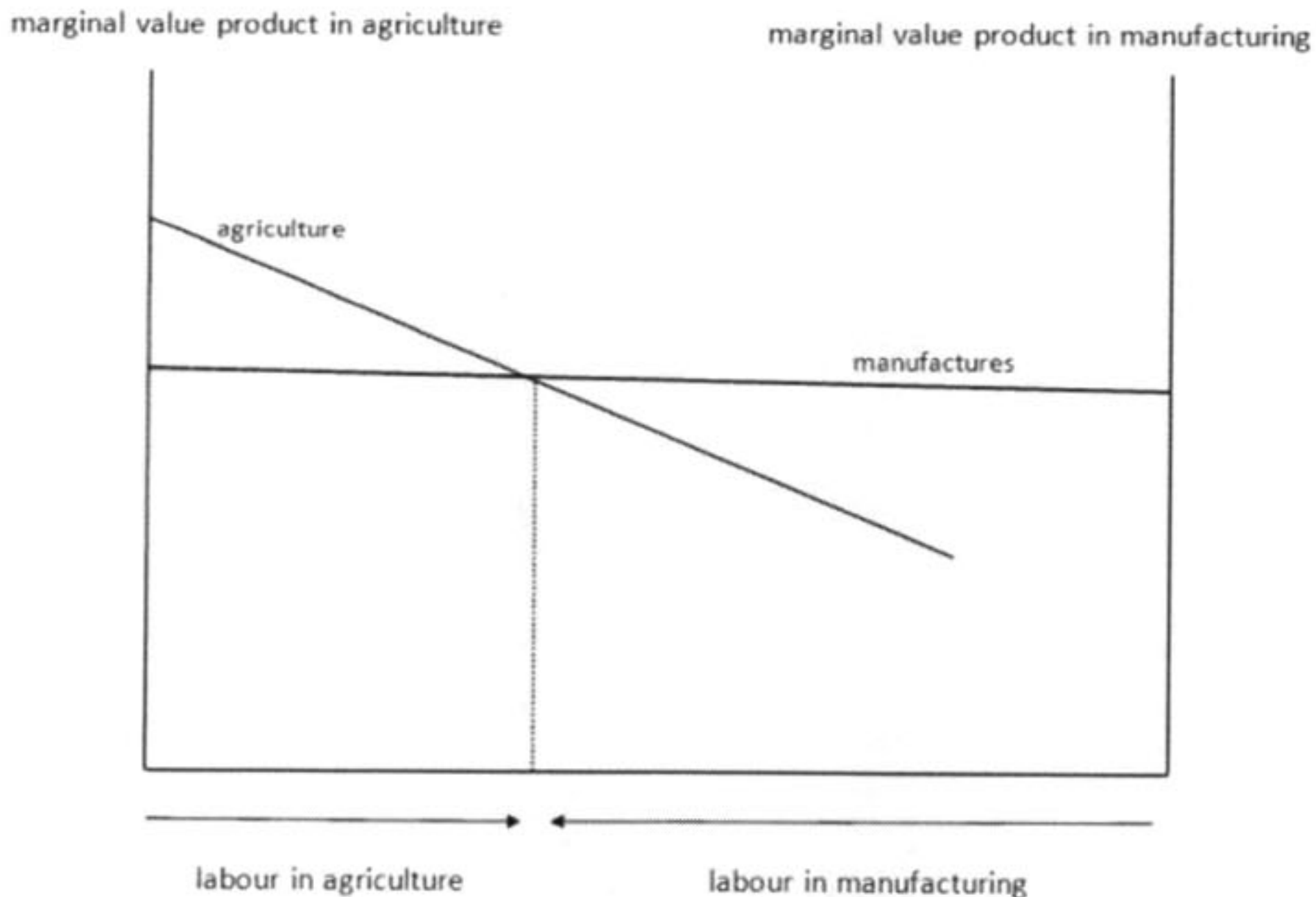
3   Markets and Men?

In the wake of conflicts over development of the 1920s the newly arrived Australian economics profession felt an opportunity to bring some economic analysis to bear on the issues.

The first attempt to consider the matter of population with any analytic power was the 1929 officially sponsored inquiry into protectionism, *The Australian Tariff: an Economic Enquiry* (Brigden *et al.* 1929). Not surprisingly, the authors of the *Enquiry* considered population growth in the context of a small open economy, and in the light of the common perception of inter-war Australia that international trade and population were linked as agents of development: as the well-known slogan had it, there was an ambition for both 'markets and men'. But there was a range of views of how trade and population cohered. Were they substitutes or complements? Or were they, in fact, antithetical? Would the promotion of import replacement exploit the opportunities of a larger population? Or would a larger population erode the high living standards that tariffs supposedly made possible? Might a larger population be a better means than protection of obtaining the scale that Australia's small economy so lacked?

The Australian Tariff gave no countenance to the notion that a larger population would be 'developing'. It deployed what were in effect Ricardian assumptions to suggest that while a larger population would not threaten the 'living standard' of the wage earner (so famously the concern of Australian policy), it nevertheless would diminish per capita incomes. Thus while its logic acquitted a larger population of harming the wage earner, a larger population could not be considered advancing of the economy.

The working model behind the *Enquiry*'s position on population (see Brigden 1927) conceived of the Australian economy as composed of two sectors: an agricultural sector, where a diminishing marginal productivity of labour prevailed; and a manufacturing sector where a constant marginal productivity of labour prevailed (Figure 1, and Coleman, Cornish and Hagger 2006: 63-4, 80-4), a conception that obviously drew heavily on classical trade theory (Coleman, Cornish and Hagger 2006: 63-4). The *Enquiry*'s conception implied a stylised history where population growth presses down upon the marginal productivity of labour in agriculture, until it was reduced to equality with the marginal productivity of labour in manufacturing; at which point a manufacturing sector would appear, and would absorb all further population increases. The expansion of the manufacturing sector, then, would stave off further declines in marginal productivity of labour, and wages. Nevertheless, the per capita income in the economy would *still* decrease with every increase in population, since the average productivity of labour in the ever expanding manufacturing would be less than average productivity in the now stationary agricultural sector (see Figure 2). The upshot of this logic was that the *Enquiry* was tacitly anti-populationist.
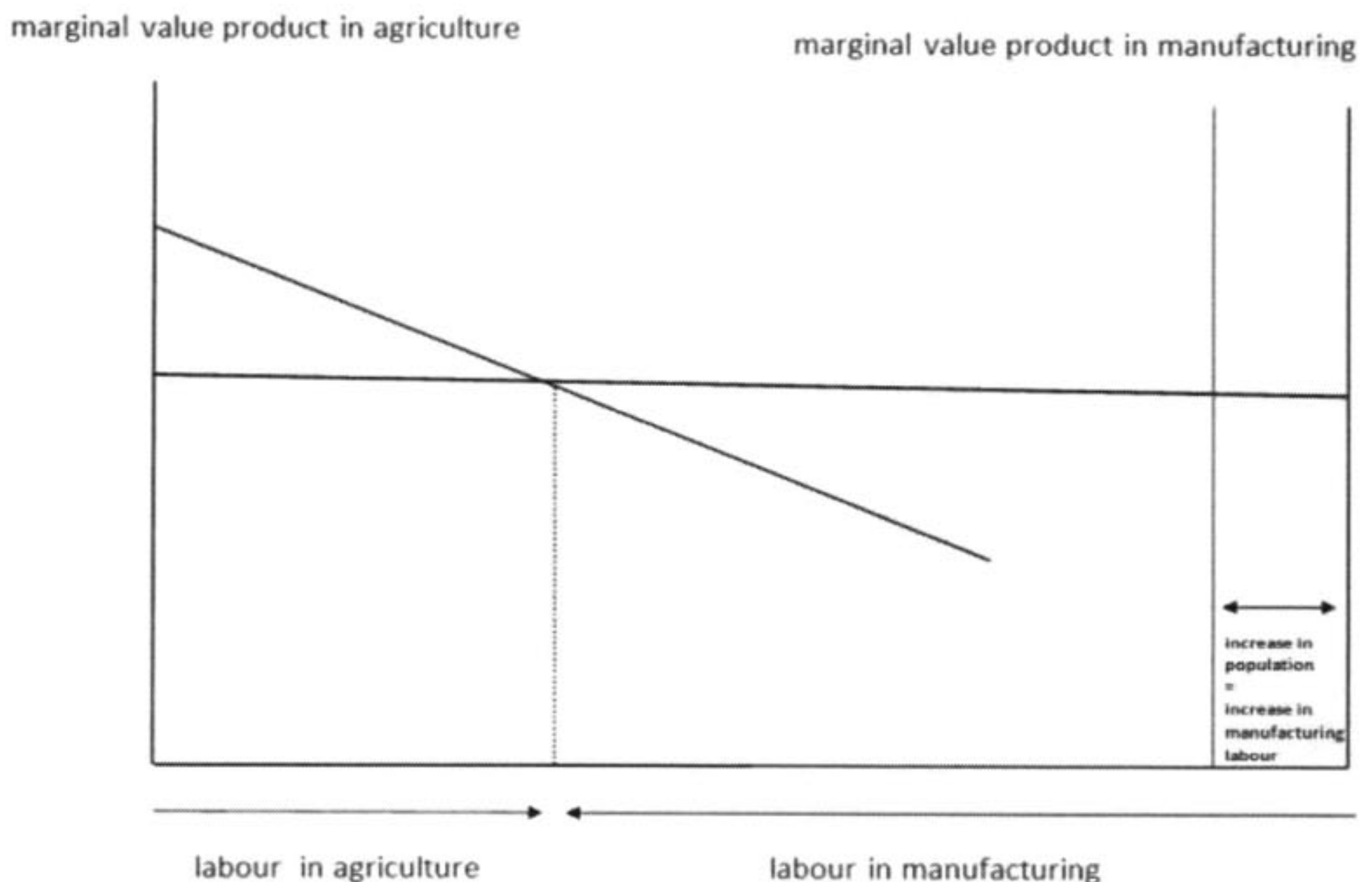
Figure 1

The 'Brigden Report' Two Sector Model

marginal value product in agriculture

marginal value product in manufacturing

agriculture

manufactures

labour in agriculture

labour in manufacturing

But a bolder sense of possibility in the *Enquiry*'s authors might have left them in some doubt of the inevitability of diminishing per capita income in the face of a larger population. Suppose Australia's population could be (somehow) returned to

its level of a century before: would it really be true that 1829's population of about 65,000 would provide Australians a higher living standard than 1929's population of 6.5 million? Was there, indeed, any evidence of a Ricardian pressure on living standards over the previous hundred years when Australia's European population was growing one hundredfold? Ricardian productivity effects, it would seem, must have been balanced by the Smithian effects of specialisation; effects that had been stressed by E.G. Wakefield's championing of a larger population for Australia exactly a century before (1929 [1829]). That inference of a joint operation of Smithian and Ricardian productivity effects provided the context for the blooming of the concept of 'optimum population' in Australian policy debates in the inter-war years.

Figure 2

An Increase in Population in the Brigden Report Model

marginal value product in agriculture

marginal value product in manufacturing

increase in population = increase in manufacturing labour

labour in agriculture   labour in manufacturing
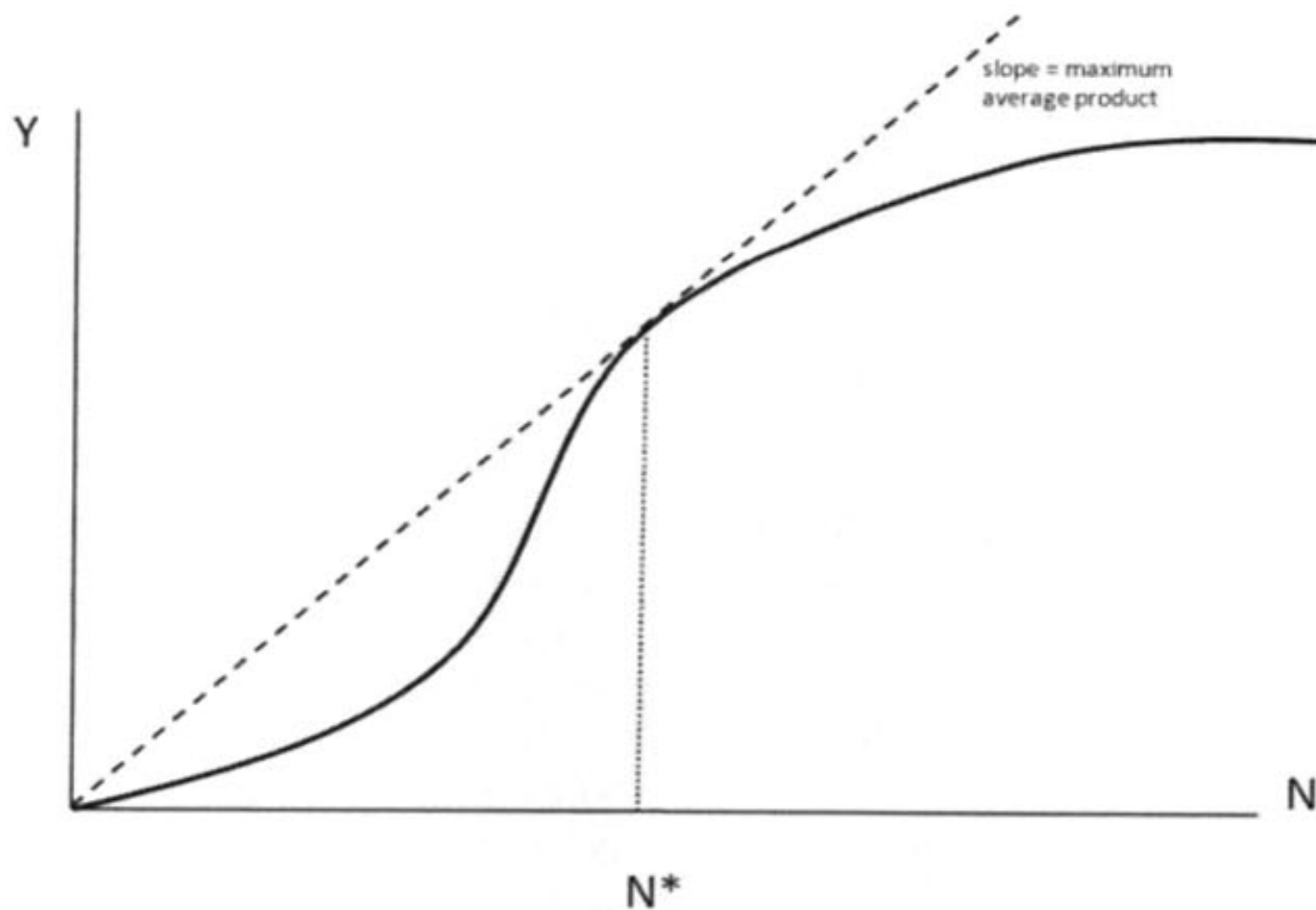
4   Optimal Population

This concept of optimum population supposed there was some unique population level – the optimum – that would, in given circumstances, maximise any given country's output per head. This notion had two founts: Knut Wicksell and Edwin Cannan (see Gottlieb 1945 for a survey of the theory).

The notion of an optimum population had been first aired by Wicksell, who, having thrown over the evangelical Christianity of his youth, had adopted birth control as his religion. This new faith raised an economic question that the Malthusianism of classical economics could never sensibly ask. In the Malthusian vision population was endogenous; so no matter what technical conditions prevailed, the population would adjust until per capita income was at that level such that net reproduction was zero. But if population was no longer endogenous, and could be made to some extent a policy choice variable, then a 'best population' –

the one that maximised per capita income – could became a rational goal (see Wicksell's 1910 pamphlet 'The Two Population Questions', reprinted in Fong 1976). This conception would have been reinforced by Wicksell's work on optimal scale of the firm. The notion of a scale that was not wastefully small or wastefully large was clearly suggestive of an optimal scale of an economy, and therefore of its population.

But it was Edwin Cannan at the London School of Economics who most effectively disseminated a distinct rationale for the existence of a unique per-capita-income-maximising level of population. Its existence reflected, according to Cannan, the operation within an economy of both diminishing and increasing returns (Cannan 1914). If returns were diminishing at all levels of population, then income per head evidently would rise with every reduction in population (the Ricardian effect); and the optimum would be indefinitely small. But if returns were increasing with every increase in population then clearly income per head would rise with every increase in population (Smithian effects); and the optimum would be indefinitely large. But suppose at low levels of labour input Smithian 'division of labour' were powerful and increases in labour reaped productivity gains through making possible specialisation. Suppose also, however, that at higher levels of labour input these benefits of specialisation were counterweighed by the reduced productivity of labour (manifested in the burgeoning of Ricardian rents) that will be consequent upon the greater ratio of labour to natural resources.[2] Specifically, suppose that returns were diminishing for low population, say below N^* but increasing above N^*. Then output per head is maximised at N^*, the point where the elasticity of output to labour is unitary. N^* is the optimal population (see Figure 3).

Figure 3

The Benhamite Optimum Population

5   **The Benhamite Population Optimum**

It was from Cannan's classrooms that there arrived in 1923 at Sydney University F.C. Benham, 'of those days ... a self-confident, occasionally even brash, young

man' (Butlin 1962: 386). He threw himself into Australian policy debates and quickly identified himself as a forward adversary of Australian protectionism (Benham 1926). In a chapter of *The Peopling of Australia* (1930) Benham ventured the first estimate of Australia's optimal population.

Benham explains that at low population levels 'a greater population will be able to take fuller advantage of economic co-operation per head'; but at a sufficiently high population 'instead of new occupations being created [in response to more people], there would simply be more persons in each existing occupation', and the reduced 'natural resources per head' would dominate (Benham 1930a: 254). He moves forthwith from these *a priori* considerations to declare, 'I am inclined to think that optimal population [of Australia] is somewhere between 10 and 15m' (Benham 1930a: 257). Regrettably, Benham gives barely any justification of this conjecture, beyond suggesting that diminishing returns were not currently operating in Australia, since between 1901 and 1913 productivity of labour rose by 30 per cent; a shaky inference that neglects both the role of technical progress and capital accumulation in increasing average labour productivity. Perhaps Benham felt the thinness of his case because in his own, *The Prosperity of Australia: An Economic Analysis*, he shies off advancing any number for optimal population. In considering the impact of greater population on 'division of labour' and reduced natural resources per head, he concludes 'it is impossible to say which of these tendencies would outweigh the other' (Benham 1930b).

But apart from such empirical uncertainties, there are significant theoretical difficulties with the 'Benhamite' notion of optimal population.

Firstly, there is the embarrassment that at the Benhamite optimum all output is paid to labour. (This property of the optimum is underlined by Pitchford 1974: at the optimum the average product of labour equals the marginal product of labour). Thus the Benhamite optimum inadvertently takes the appearance of the Wakefieldian workers' paradise and landowners' nightmare. The optimum is supremely optimal for labour, but 'pessimal' for other factors.[3]

That the Benhamite optimum has a wages share of 100 per cent at the optimum suggests we need to dig a bit deeper into the technology represented in Figure 3. But one obvious rationalisation is fundamentally damaging of the Benhamite optimum. Let the production relation of Figure 3 be rationalised as fundamentally one between the output per unit of natural resources, $Y/R = y$, and and factor *intensity*: labour per unit of resources, $N/R = n$.

$$y = y(n)$$

In such a rationalisation of the Benhamite production relationship we would be free to suppose that the average productivity of labour rises with labour per unit of resources until some critical intensity is reached, n^*; and above that critical intensity the average productivity of labour falls with labour per unit of resources.

The defect of such an 'intensity' characterisation of Figure 3 is that it does not, in fact, imply a unique 'optimal population'; for under this 'intensity' characterisation the maximum average product of labour can be secured no matter how small the supply of labour. Proof: in Figure 4 the average product of labour is evidently maximised at n^*, as that is the location of the steepest ray from the origin that intercepts the production function (and the slope of any ray equals $Y/N = (Y/R)/(N/R)$). But n^* can be secured no matter how small the total supply of labour *simply by leaving some natural resources ('land') idle*. Thus all the productivity benefits that were supposedly dependent on a 'large' population may

be secured by even the smallest population. This contention is underlined by noting the fact that the marginal product of R ('land') at any intensity less than n^* is *negative*, and, in consequence, if N is indeed less than n^*R then a certain amount of R ('land') will be rationally left idle; an amount sufficiently large to make N equal to n^* times *cultivated R*, and the ratio of labour to cultivated 'land' equal to n^*.[4] The upshot is that for all N less than n^*R, an increase in N would not cause an increase in the labour intensity with which natural resources are actually worked; it would only reduce the amount of land left idle. The 'very march of the frontier' that excited populationists is revealed as no other than the market maintaining the productivity of labour at its maximum in the face of greater population.[5]

Figure 4

Average Labour Productivity Maximised No Matter How Few People
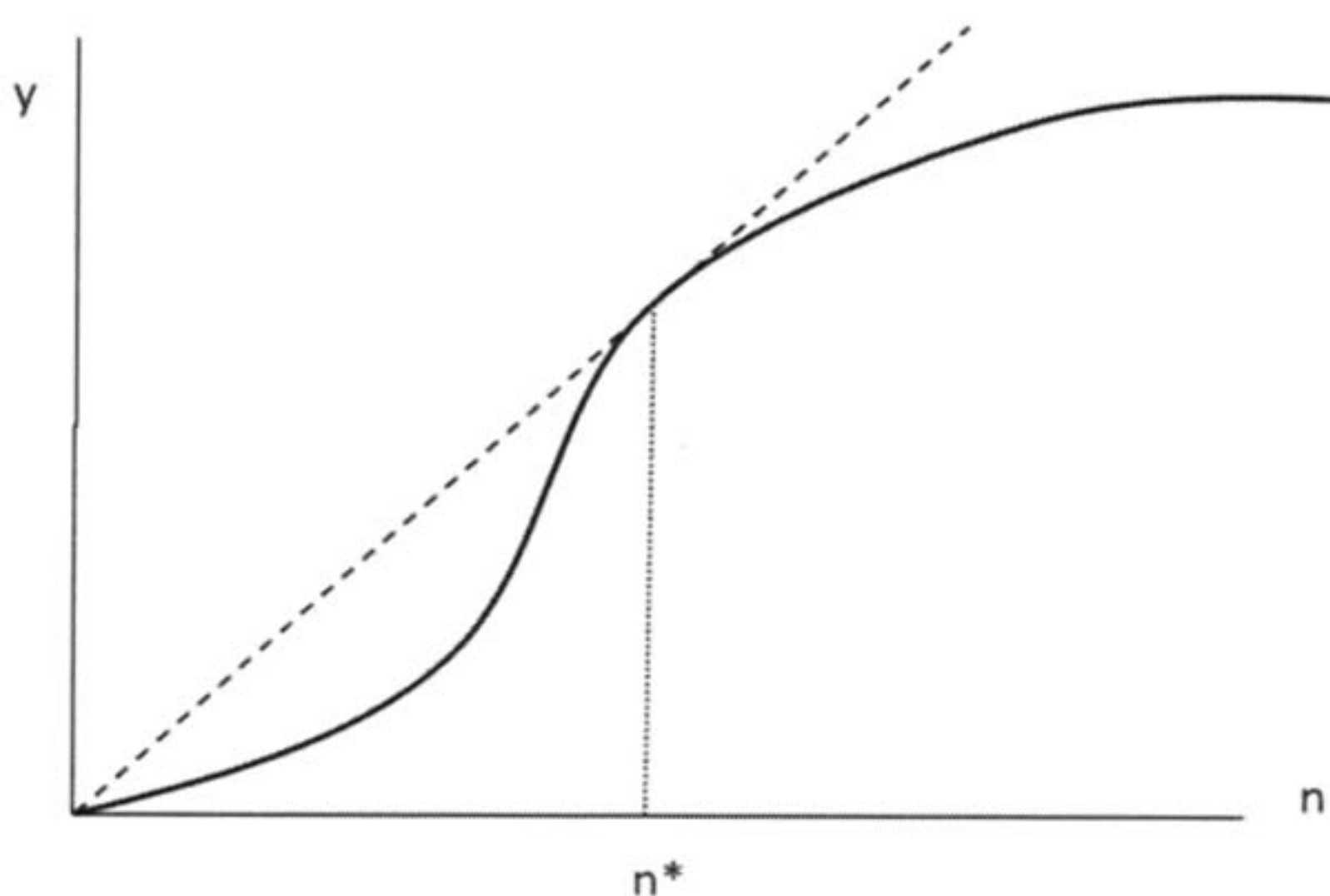
The Benhamite optimum might seek – and find – refuge in other rationalisations of Figure 3. They might argue that the *intensity* rationalisation of Figure 4 is a misrepresentation of Figure 3. For, they might argue, the posited increase in average productivity with population turns on the *scale* of inputs, rather than intensity. In this scale interpretation it will make all the difference to the average productivity of labour whether one hour of labour is applied to one square metre of land; or a million hours are applied to a million square metres.

In mathematical terms, the scale interpretation of Figure 3 could be captured by supposing output of enterprise i is expressed by,

$$\frac{Y_i}{R_i} = y(\frac{N_i}{R_i})s(N_i)$$

$$s'(N_i) > 0 \quad \text{for} \quad N_i < N!$$

$$y'(n) > 0; \; y''(n) < 0; \; \text{for all } n.[6]$$

Here $s(N_i)$ is supposed to increase until N equals a maximising magnitude, $N!$.[7] The $s(N_i)$ function simply captures the thesis that the average productivity of labour,

$$\frac{Y_i}{N_i} = \frac{y(N_i/R_i)}{N_i/R_i} s(N_i)$$

is not solely a function of the ratio of labour to resources, but will be increased by a larger absolute scale of employment . But will this characterisation yield, for a given aggregate R, the relationship in Figure 3? Unfortunately for the Benhamite optimum, it will not. For any income-maximising entrepreneur will always chose employment N_i, so that $N_i = N!$,

$$s'(N_i) = 0$$

and the scale economies of employment are exhausted.[8] Thus all the phenomenon of scale ensures is that no enterprise employs fewer than a certain minimum, $N!$, and there are, in other words, no 'backyard' steel furnaces. But with that constraint on minimum employment per firm observed, the relationship between average product of labour and the labour supply would be the orthodox, monotonically decreasing one.[9]

The only way scale economies would not be exhausted by the profit-maximising employment choices of the enterprise would be if not even the entire workforce was large enough to secure an efficient scale, and so,

$$s'(N) > 0$$

In this circumstance not even a single firm the size of the economy was of optimal scale. This hardly seems to accord with the existence of many firms, even within a given industry.

Thus the appeal to scale seems not to create a case for a Benhamite optimum. Yet a different kind of scale phenomenon might still do the trick. Consider scale benefits that are *external* to the enterprise; that is, the situation where an industry experiences scale effects as it grows, but where no single enterprise has the private incentive to try to reap them fully by increasing their own scale. Such a limitation on the exploitation of scale benefits, on account of their externality, would entail benefit from a larger population, as a larger population supplies the scale that industry could not. But how could such external economies arise? Consider this scenario: suppose the benefits of a Smithian division of labour extend almost indefinitely. But suppose also that a single firm cannot exploit them all, on account of the familiar 'Coasian' diseconomies becoming large (for example, in the large enterprise information flows deteriorate, and the successful solution of optimal resource allocation by command methods becomes prohibitively expensive). This would mean that a single pin factory attempting to occupy the entire industry would be just 'overgrown' no matter how impressively articulated its division of labour. In consequence the way an industry reaps the scale benefits of an increased size is by spawning more enterprises as it grows in size. The new enterprises will not do the same thing as the old (that would not articulate the specialisation of labour) – but will create and fill specialisations within the industry; so one firm in the pin industry will 'draw out the wire', another will 'straighten it', a third will 'cut it', and so on. If this scenario is considered persuasive then we may conclude that there do exist benefits from increases in specialisation that flow from increased scale, that will only be secured by a larger population.

But how compelling is this scenario?[10] Again, Benham's apparently simple rationale for optimal population loses itself in a tangle of considerations and imponderables.

6 The Smithiesian Population Optimum

Not long after Benham's effort, a different attempt at theoretical rationalisation of optimum population was provided Arthur Smithies in 1938, during his brief sojourn in Australia, at the Commonwealth Bureau of Census and Statistics, following his completion of his doctoral degree under J.A. Schumpeter at Harvard. Smithies's 'The Advantages of a Larger Population'(Smithies 1938) appears in *Australian Population*, a publication of the Australian Institute of International Affairs, then presided over by E.C. Dyason, the maverick businessmen and co-author with Brigden (and others) of *The Australian Tariff* (1929).

Smithies begins by dismissing military and cultural arguments for larger population, and resolving that 'the arguments for and against larger population must rest almost entirely on economic grounds'.[11] Rather than investigate these economic grounds using a single-good model, Smithies considers a two-sector economy, just as *The Australian Tariff* did implicitly. But whereas *The Australian Tariff* assumed constant marginal productivity in manufacturing, Smithies explores the implication of increasing marginal productivity in manufacturing, as 'there seems to be no reason why increasing return should not obtain in the processing of manufactures in Australia' (Smithies 1938: 13). He used this alternative assumption to demonstrate that a larger population can increase per capita income.

Consider, said Smithies, an economy that consumes a manufacturing good ('boots') and an agricultural good ('potatoes'). Suppose also (as Smithies did implicitly) that the utility function is separable,

$$U = u(B) + v(P)$$

Suppose also that while 'potatoes' are produced under diminishing marginal productivity of labour,

$$P = P(N_P) \; ; \; P''(N_P) < 0$$

'boots' are produced under increasing marginal productivity.

$$B = B(N_B) \; ; \; B''(N_B) > 0$$

There obviously exists a welfare efficient allocation of the total labour supply, N, between the two sectors, that can be usefully represented as in Figure 5 (not drawn by Smithies). This Figure plots the 'marginal utility product of potato labour' (= marginal utility of potatoes *times* marginal potato product of labour) and the 'marginal utility product of boots labour', and identifies the allocation that is optimal with the intersection of the two schedules.[12]

Going beyond that static equilibrium of Figure 5, Figure 6 reveals the critical comparative-static result: that an increase in population would increase the marginal utility product of labour in *both* sectors. The significance of this comparative-static result is underlined by defining the 'average utility product' of labour in each sector,

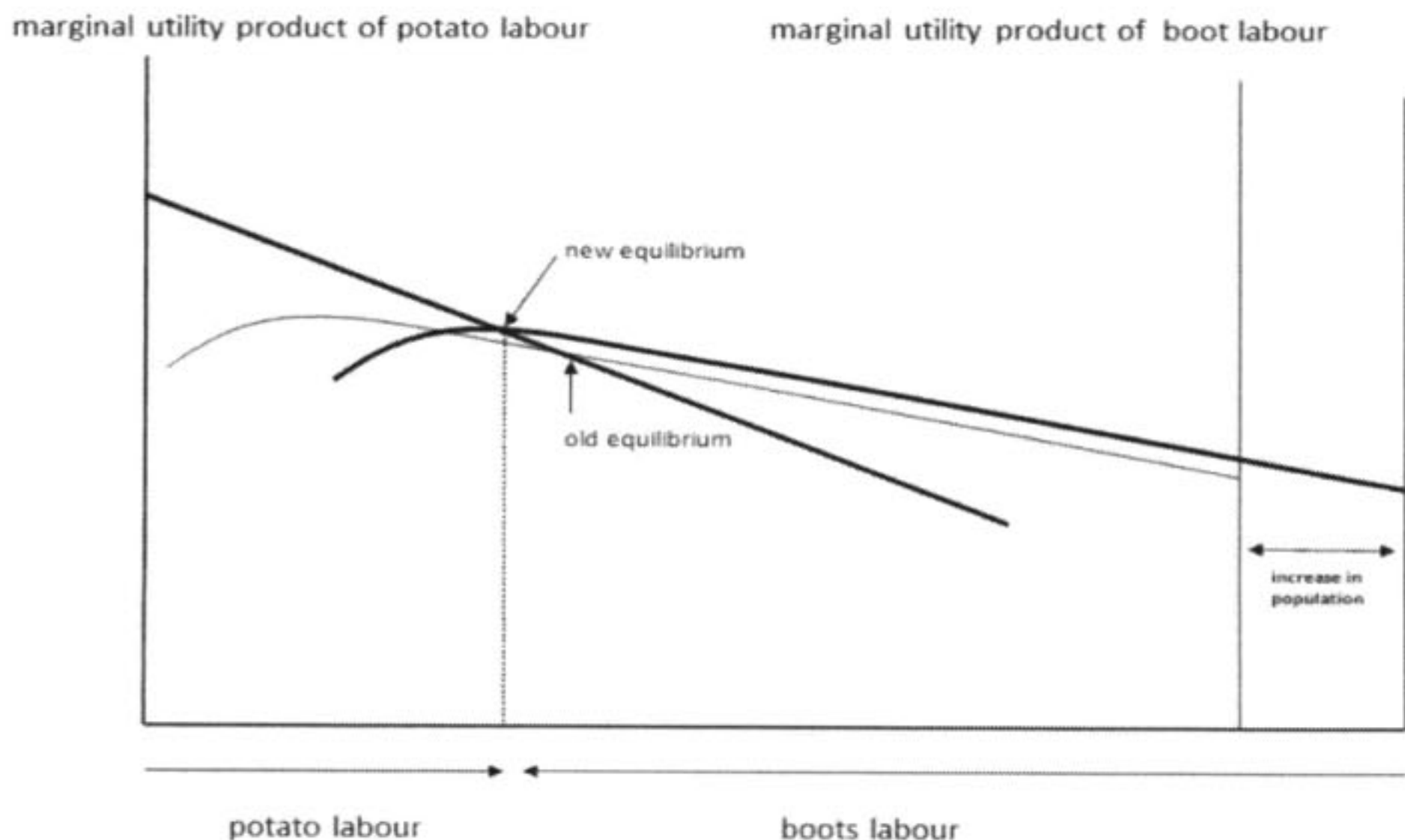$$\text{average utility product of boot labour} = \frac{u(B)}{N_B}$$

$$\text{average utility product of potato labour} = \frac{\upsilon(P)}{N_P}$$

Figure 5

A Smithiesian Equilibrium

marginal utility product of potato labour

marginal utility product of boots labour

potatoes

boots

potato labour   boots labour
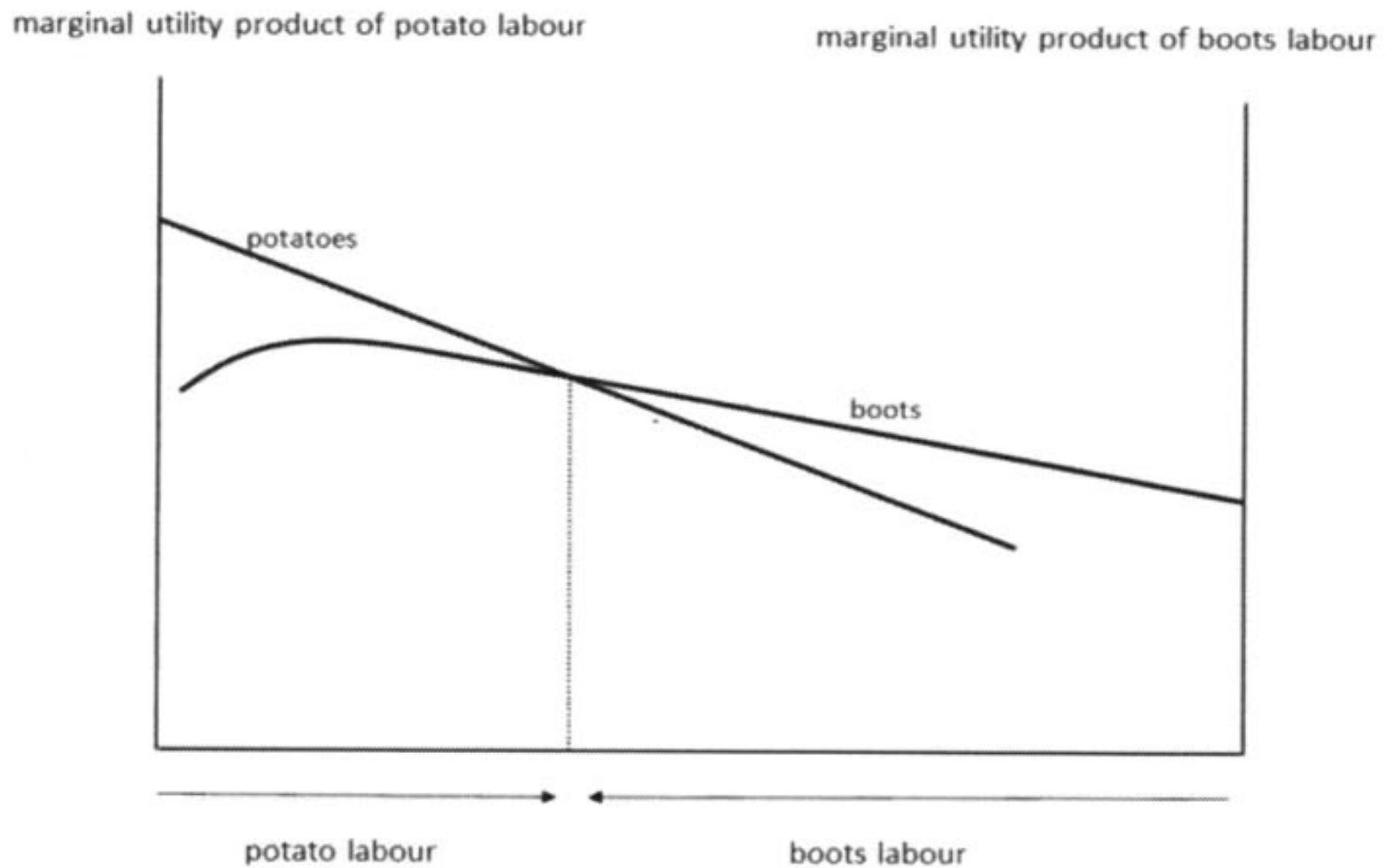
Given a monotonic mapping between marginal and average products,[13] we can easily infer from the increase in both marginal utility products that the two average utility products must also have increased consequent to an increase in *N*. Thus in both sectors each worker is now generating more utility than each did under a smaller population. In conclusion, a larger population has, it would seem, increased average welfare.

Figure 6

Everybody happier with the more population (?)

marginal utility product of potato labour   marginal utility product of boot labour

new equilibrium

old equilibrium

increase in population

potato labour   boots labour

But larger population cannot be indefinitely increasing of the average utility product of both sectors. Figure 6 also has the marginal utility product of boots labour ultimately diminishing on account of the diminishing marginal utility of boots (as manifested in the downward sloping portion of the marginal utility product of boots labour). It is easy to see that a sufficiently large increase in population would bring that downward portion into play, with negative consequences for the average utility product of both sectors. Thus the overall conclusion is that some extra population is improving overall average utility product, but not an unlimited increase: 'there is a magnitude of population which realises the maximum standard of consumption' (Smithies 1938).[14]

Smithies's rationalisation of an optimum population has some ingenuity about it. It does not gratuitously invoke universal increasing returns, but posits its presence in one sector, a sector, furthermore, that may be 'small' in relation to the total economy. But to the modern critic Smithies's notion invokes an array of theoretical problems that his informal treatment is negligent or cavalier in treating. Firstly, the argument above does not, in fact, strictly imply that a larger population increases utility per head. It is an arithmetical truth (if a 'paradoxical' one) that to increase the average utility product of labour in both sectors is not necessarily to increase average utility of total labour. This is because a larger population (necessarily) reduces labour in agriculture, and agricultural labour possibly has a larger average utility product than boot labour. In this possibility, although each sector experiences an increase in average utility product, the sector with the higher average utility product (agriculture) contracts, to the possible detriment of total utility per unit of labour, or 'per capita utility'.

This qualification to the force of Smithies's argument above can be explored more formally by defining 'per capita utility' as,

$$\text{per capita utility} = \frac{u(B) + \upsilon(P)}{N}.$$

It is a simple matter to show that,

$$\frac{\partial \text{ per capita utility}}{\partial N} > 0$$

as

$$\upsilon'(P)P'(N_P) > \frac{u(B) + \upsilon(P)}{N}$$

Thus per capita utilty is (is not) increased by population as the marginal utility product of labour in potatoes exceeds (does not exceed) per capita utility.[15] And this may or may not be the case. This theoretical ambiguity can be represented diagrammatically by choosing units so that $N = 1$, with the implication that,

$$\frac{u(B) + \upsilon(P)}{N} = u(B) + \upsilon(P)$$

and so 'per capita' utility may be measured by the area under the marginal utility product schedules.[16] Further, since, by choice of units, $N = 1$, we may write,

$$\upsilon'(P)P'(N_P) = \upsilon'(P)P'(N_P)N$$

and so the marginal utility product of labour in potatoes may be measured by the area formed by the rectangle that is enclosed by the horizontal axis and the parallel

that passes through the intersection of the two marginal schedules. The comparison of the area of the rectangle with the area under the marginal product schedules governs the impact of higher population. Figures 7 and 8 implement this comparison: in Figure 7 the measure of $v'(P)P'(N_P)$ (the shaded area) is larger than the measure of per capita utility (the area under the marginal schedules in bold); and in Figure 8 the reverse. Considered together, they suggest that the 'larger' the manufacturing sector the more likely population will be improving of per capita income, which makes intuitive sense given the assumptions of the model.
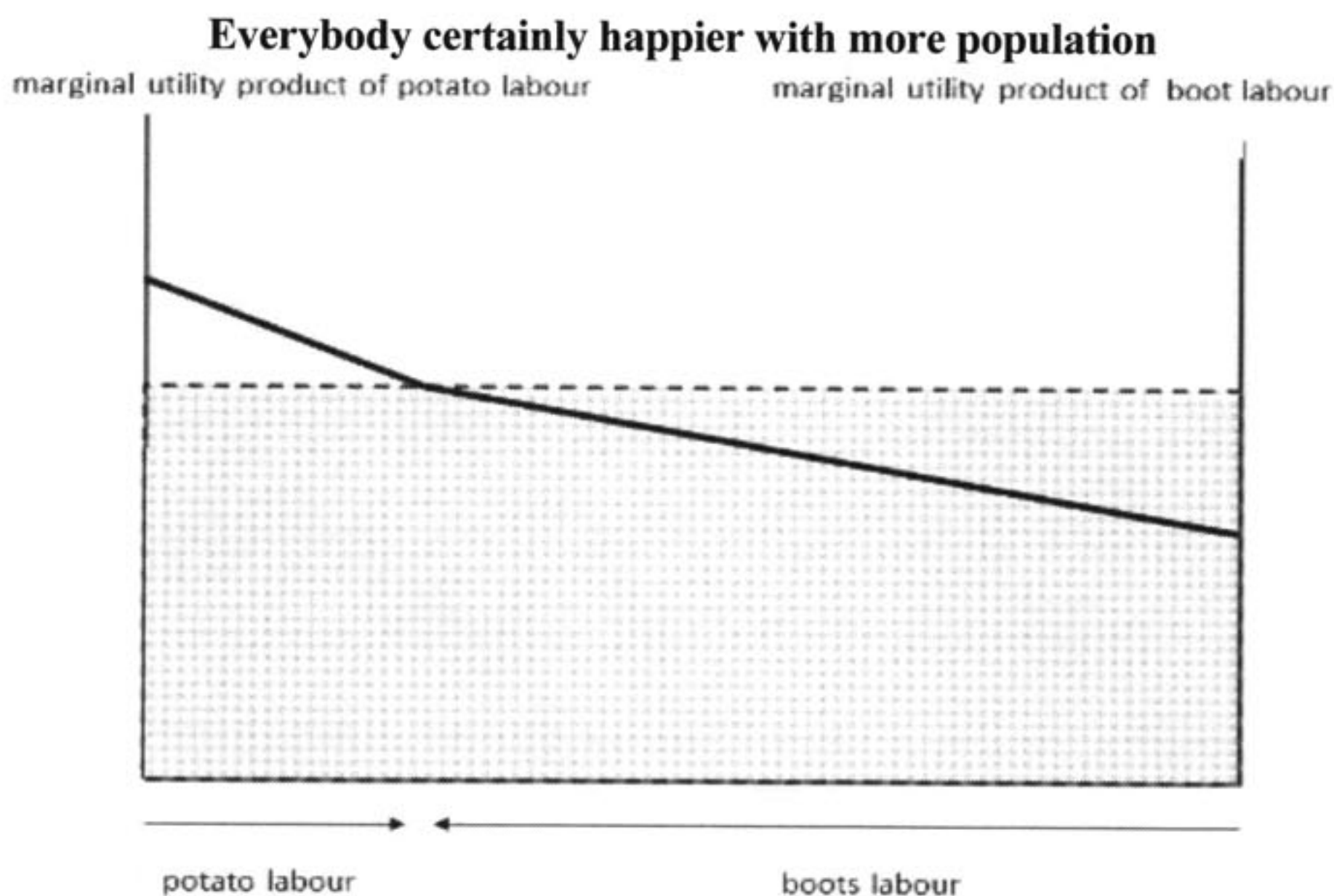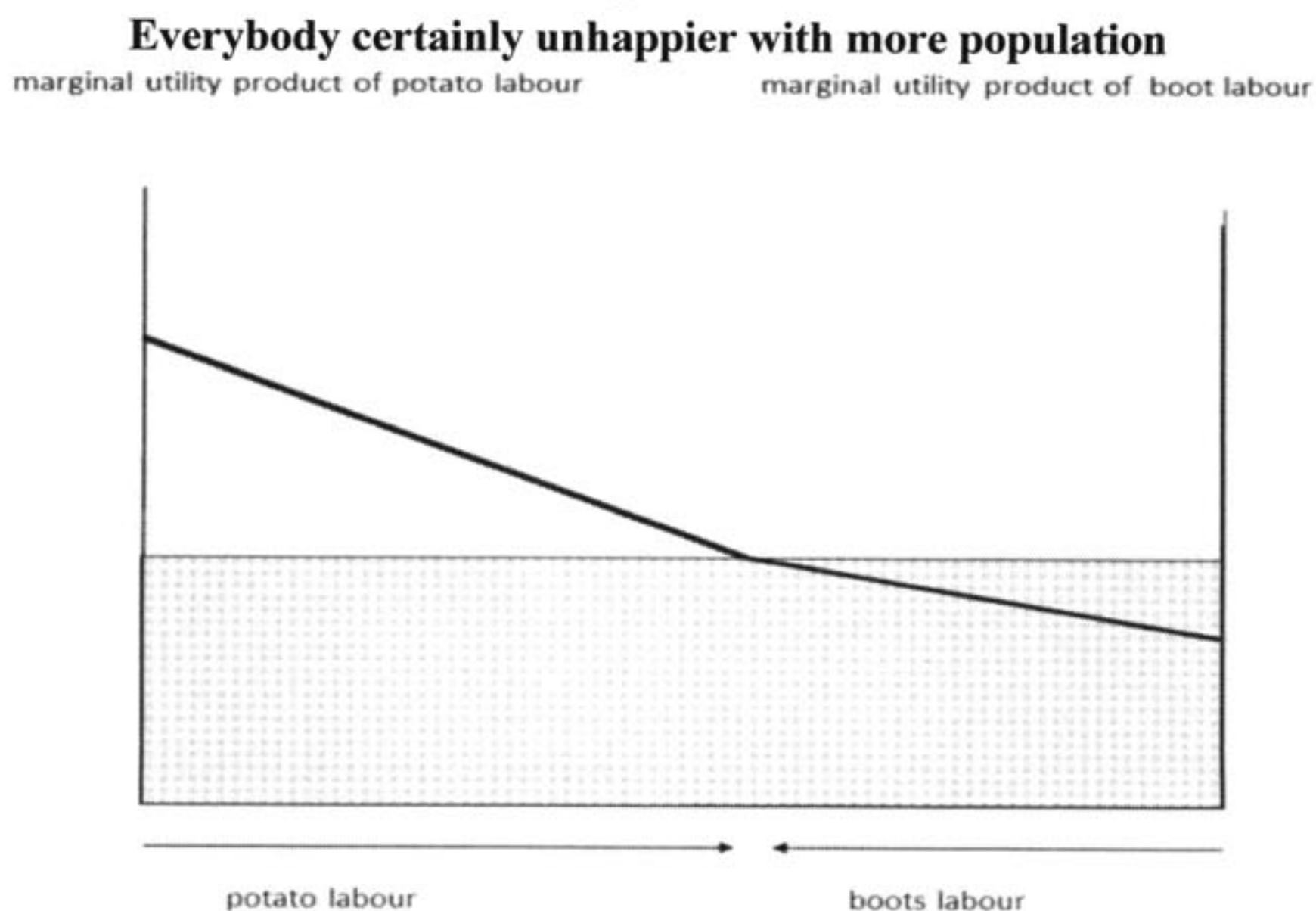
Figure 7

Everybody certainly happier with more population

marginal utility product of potato labour   marginal utility product of boot labour

potato labour   boots labour

Figure 8

Everybody certainly unhappier with more population

marginal utility product of potato labour   marginal utility product of boot labour

potato labour   boots labour

There is a second weakness in Smithies's argument: beyond its possible insufficiency as rationale for the existence of an optimum population, Smithies's

hypothesis of increasing marginal products also (famously) plays mayhem with neoclassical distribution analysis. Certainly, it is impossible for labour to be paid its marginal product in boots as long as marginal productivity is increasing, and consequently the equimarginal product characterisation of the allocation of labour in Figure 5 will not represent the *market* equilibrium. This does not affect the validity of Smithies's account of the welfare efficient optimum, but we are left wondering about the relation of the market outcome to that welfare efficient optimum, and how one might shift that market outcome to the optimum. Again, an apparently simple economic rationale of an optimum population proves problematic.

A third weakness of Smithies's model is that – like the models of Benham and the Brigden Report – it is articulated in terms of 'labour' and 'natural resources': capital is not integrally accounted for. One simple manoeuvre to try to account for capital would be to redefine 'R' in the models as capital. But this stratagem has at least three deficiencies. It ignores the distinctive dimensions of capital that an allowance for capital spells for the problem of optimal population. Thus the indivisibility of capital structures (for example, a railway) can, as Smithies notes, imply benefits from a larger population, as per capita overheads are reduced. Such indivisibility has no obvious counterpart in natural resources, and is not captured by the production functions we have considered. With a similar consequence, Benham noted the existence of a 'division of capital' (for example, a large manufacturer will use a greater variety of tools than a cottage enterprise); and this too has no obvious counterpart in natural resources. Secondly, capital – unlike natural resources – is endogenous, and explanation of capital accumulation must be incorporated into any analysis. Finally, as capital is accumulated over time, the maximisation problem becomes inherently intertemporal rather than static.

7   Conclusion

However incomplete and theoretically beleaguered was the notion of optimum population, several Australian economists in the 1930s and war years felt they could show the existence of an optimum, and even quantify it. Thus the Queensland Bureau of Industry, under the direction of Colin Clark, estimated Queensland's optimal population at five million. The Bureau also deemed the optimum size of a Queensland city to be 200,000, perhaps surprisingly low.

In the postwar period, however, the attraction of the concept of optimum population waned. Already by 1949 Peter Karmel, the economist most expert in demographic issues at the time, asserted that, 'with regard to the optimum population of Australia, it should frankly be stated that we have very little knowledge of what such a population should be' (Karmel 1949: 21). Certainly, economists in the subsequent 50 years showed little interest in the concept. Pitchford (1974) appears to be the only postwar theorist who explores it. Applied economists concerned with population refused the concept,[17] and in preference to any population goal, recommended a 'population consciousness' in policy formulation. Perhaps Australia's rapid growth in population in the postwar period took the wind out of estimates of the optimum, as population glided past the lower bound of Benham's '10-15 millions' in 1959, and the upper bound in 1981; and, for all that, GDP per head continued to grow.

In retrospect, it should be allowed that the materials that Benham and Smithies were using to construct the theories were, and remain, strong and fundamental:

Smithian and Ricardian productivity effects should loom in any contemporary consideration of the impact of population on the Australian standard of living. But the lesson of Benham's and Smithies's thought is that these strong materials do not always make for successful simple analytical structures.

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Notes

1   'Australia', said Mr Hughes, 'is big enough for a population five times its present size. It wants more people' (*Barrier Miner*, 27 October 1920).
2   Wicksell's case in the *Lectures* for the optimum is essentially the same as Cannan: 'the services which persons in a newly settled countries can render each other by cooperation in defence against wild animals or hostile tribes, by the building of roads and by the establishment of schools, and the advantages of combination and the division of labour must with an increasing population, outweigh the inconveniences of a smaller allocation of land to each person. The point at which the two opposing influences are balanced is the *optimum population*' (Wicksell 1934 [1911]: 123). It is worth noting, however, the trade-off between Smithian and Ricardian influences on productivity is not actually mentioned in Wicksell's 1910 'The Two Population Questions'.
3   Of course, one could imagine redistributions between factors so that the optimum actually improves all.

4
$$\frac{\partial Y}{\partial R} = y(n) - ny'$$

But
$$\frac{\partial y}{\partial n} = \frac{y'(n)n - y(n)}{n^2}$$

Thus if $\frac{\partial y}{\partial n} > 0$ then $\frac{\partial Y}{\partial R} < 0$

5   This simply registers the well-known proposition that in the production relation depicted in Figure 4 we are always in the region in excess of n^* (see Stigler 1952; Patinkin 1973: 792).
6   One might posit that the scale factor lies in the scale of resources:

$$\frac{Y_i}{R_i} = y(\frac{N_i}{R_i})s(R_i)$$

$$s'(R_i) > 0 \quad \text{for} \quad R_i < R!$$

$$y'(n) > 0 \quad \text{for all } n.$$

but where is the benefit of a larger population in that?
7   In also supposing $s'' < 0$ it is being supposed that $s(N_i)$ is a 'hill', and in consequence there is a unique maximising scale of employment. Alternatively $s(N_i)$ could be supposed to plateau at $N!$. There seems no significance in making either assumption over the other.
8   Intuitively it easy to see that the income-maximising entrepreneur will set $N_i = N!$. Suppose $N! = 100$, but (contrary to hypothesis) two entrepreneurs chose to work with

just 50 units of labour each. It would be Pareto improving for them to combine their inputs. More formally, the entrepreneurs' maximisation problem is ,

$$\pi = R_i y(\frac{N_i}{R_i})s(N_i) - wN_i - rR_i$$

The first order conditions state,

$$\pi_N = R_i y(\frac{N_i}{R_i})s'(N_i) + y'(\frac{N_i}{R_i})s(N_i) - w = 0$$

$$\pi_R = -\frac{N_i}{R_i}y'(\frac{N_i}{R_i})s(N_i) + y(\frac{N_i}{R_i})s(N_i) - r = 0$$

Sufficient second order conditions for a maximum are,

$$\pi_{NN} < 0, \; \pi_{RR} < 0$$

and

$$\pi_{NN}\pi_{RR} > \pi_{NR}^{2}$$

Given,

$$\pi_{NN} = Ry(\frac{N_i}{R_i})s''(N) + y'(\frac{N_i}{R_i})s'(N) + y'(\frac{N_i}{R_i})s'(N_i) + \frac{1}{R_i}y''(\frac{N_i}{R_i})s(N)$$

$$\pi_{RR} = \frac{N^2}{R^3}y''(\frac{N_i}{R_i})s(N_i)$$

and

$$\pi_{NR} = -\frac{N_i}{R_i}y'(\frac{N_i}{R_i})s'(N_i) + y(\frac{N_i}{R_i})s'(N_i) - \frac{N}{R^2}y''(\frac{N_i}{R_i})s(N_i)$$

inspection will reveal that the second order conditions are satisfied at $s'(N_i)=0$.

9   The only thing that the phenomenon of optimum scale implies in this economy is the number of enterprises in the economy. The number of enterprises is $N/N!$.

10   Tibor Scitovsky was probably little exaggerating in saying '[t]he concept of external economies is one of the most elusive in economic literature', and that examples are 'not easy to find' (Scitovsky 1954: 143).

11   One non-economic benefit of larger population that is accommodated by Smithies amounts to a curious early appeal to the benefits of 'multiculturalism': 'Cultural development', Smithies suggests, 'depends on the absolute number of people engaged in its pursuit'. He then contends,

> Certainly in literature … the Middle West of the United States has given rise to the most significant movements since the War. The environment in which this literature grew was one of acute instability engendered by rapid economic development and violent racial admixture. It is the literature of feverish discontent. It is not suggested that it would be possible or desirable to reproduce the Middle West in Australia. But if migration is to take place on a large scale the immigrants will have to be drawn from non-British sources, and if they are to be absorbed their arrival must be accompanied by rapid economic development. Social instability may be anathema to Australians. We only wish to emphasise that the instability has compensations. (Smithies 1938: 5)

12   Smithies omits to notice that if there are increasing returns in boots then it may be optimising to devote *all* labour to boots. Smithies could have attempted to dispose of that possibility by registering the obvious fact that in Australia not all labour is allocated to 'boots' (that is, manufacturing). But is Australian experience relevant? Australian experience is presumably informative of the *market* allocation of labour; but the market allocation is not (under increasing marginal products) the *optimal* allocation of labour.

13   There will be monotonic mapping between the marginal and average utility products as long as the marginal utility product of labour is a monotonic function (be it positive or negative) of labour.

14   Smithies extends his analysis and reinforces his conclusion by allowing for international trade. Suppose potatoes were exported for an importable ('hats'). As a larger population would increase imports the concomitant increase in exports would reduce Australia's terms of trade. But would it necessarily? The optimum production of boots increases and perhaps by more than the demand for boots. It appears to be Smithies's judgement that the worsening of terms of trade is the critical key factor in putting a limit on the benefits of larger population.

15   Given $N_P = N - N_B$

$$\text{per capita utility} = \frac{u(B(N_B)) + \upsilon(P(N - N_B))}{N}$$

Thus,

$$\frac{\partial \text{ per capita utility}}{\partial N} = \frac{N[[u'(B)B'(N_B) - \upsilon'(P)P'(N_P)]^{\partial N_B}\big/_{\partial N} + \upsilon'(P)P'(N_P)] - [u(B) + \upsilon(P)}{N^2}$$

But an optimising allocation of labour implies,

$$u'(B)B'(N_B) = \upsilon'(P)P'(N_P)$$

and the result in the main text follows. The author is indebted to the referee for suggesting this line of thinking.

16   The words 'under the marginal utility product schedules' means the area under marginal utility of potato labour schedule to the left of the two schedules' intersection *plus* the area under marginal utility of boots labour schedule to the right of the two schedules' intersection. This area is obviously the total utility product. And as long as units are chosen so that $N = 1$, the total utility product equals the average utility product (or 'per capita utility').

17   The National Population Council's report of 1992 was heavily shaped by economists but concluded: 'It is inappropriate to enumerate an optimum population level or carrying capacity for Australia' (National Population Council 1992: 103). This was also the view of the National Population Inquiry report of 1975 (Borrie 1975: 175-91).

References

Benham, F.C. 1926. 'The Australian Tariff and the Standard of Living: a Reply', *Economic Record* 2 (2): 20-42.

Benham, F.C. 1930a. 'The Optimum Size of Population', in P.D. Phillips (ed.), *The Peopling of Australia*. Melbourne: Melbourne University Press.

Benham, F.C. 1930b. *The Prosperity of Australia: an Economic Analysis*. London: P.G. King and Son.

Borrie, W.D. 1975. 'Population Thought and Theory in Australia', in *Population and Australia: a Demographic Analysis and Projection. First Report of the National Population Inquiry*. Canberra: Government Printer.

Brady, E.J. 1918. *Australia Unlimited*. Melbourne: G. Robertson.

Brigden, J. 1926. 'The Australian Tariff and the Standard of Living', *Economic Record* 1 (1): 102-16.

Brigden, J., Copland, D.B., Dyason, E.C., Giblin, L.F. and C.H. Wickens. 1929. *The Australian Tariff: an Economic Enquiry*. Melbourne: Melbourne University Press.

Butlin, S.J. 1962. 'Frederic Benham: 1900-62', *Economic Record* 38 (83): 386-8.

Cannan, E. 1914. *Wealth: a Brief Explanation of the Causes of Economic Welfare*. King: London.

Coleman, W., Cornish, S. and A.J. Hagger. 2006. *Giblin's Platoon: the Trials and Triumph of the Economist in Australian Public Life*. Canberra: ANU EPress.

Fong, M.S. 1976. 'Knut Wicksell's "The Two Population Questions"', *History of Political Economy* 8 (3): 311-23.

Gottlieb, M. 1945. 'The Theory of Optimum Population for a Closed Economy', *Journal of Political Economy* 53 (4): 289-316.

Karmel, P. 1947. 'Population Replacement – Australia, 1947', *Economic Record* 25 (49): 83-8.

National Population Council. 1992. *Population Issues and Australia's Future: Environment, Economy and Society. Final Report*. Canberra: Australian Government Printing Service.

Patinkin, D. 1973. 'Frank Knight as Teacher', *American Economic Review* 63 (5): 787-810.

Pitchford, J.D. 1974. *The Economics of Population: an Introduction*. Canberra: Australian National University Press.

Powell, J.M. 1993. *Griffith Taylor and 'Australia unlimited'*. Brisbane: University of Queensland Press.

Scitovsky, T. 1954.'Two Concepts of External Economies', *Journal of Political Economy* 62 (2): 143-51.

Smithies, A. 1938. 'The Future of the Australian Population', in *Australian Population*. Sydney: Australian Institute of International Affairs.

Stigler, G.J. 1951. *The Theory of Price*. New York: Macmillan.

Strange, C. and A. Bashford. 2008. *Griffith Taylor*. Canberra: National Library of Australia.

Taylor, T. Griffith. 1926. 'Frontiers of Settlement in Australia', *Geographical Review*, 16 (1): 1-25.

Wakefield, E.G. 1929 [1829]. *A Letter from Sydney and Other Writings on Colonization*. London: J.M. Dent.

Wicksell, K. 1934 [1911]. *Lectures on Political Economy*, vol. 1 (transl. E. Classen, ed. L. Robbins). London: Routledge.